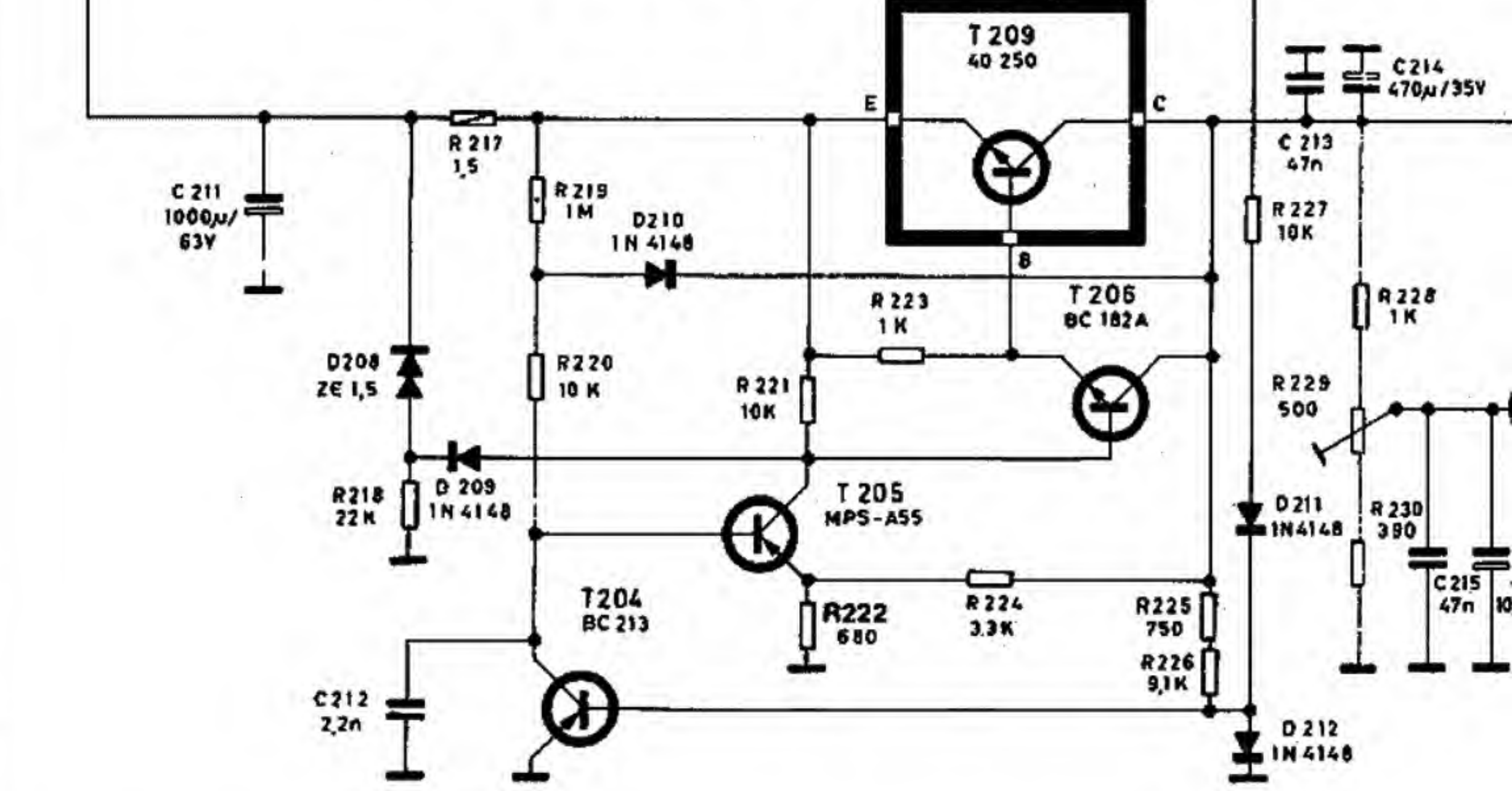
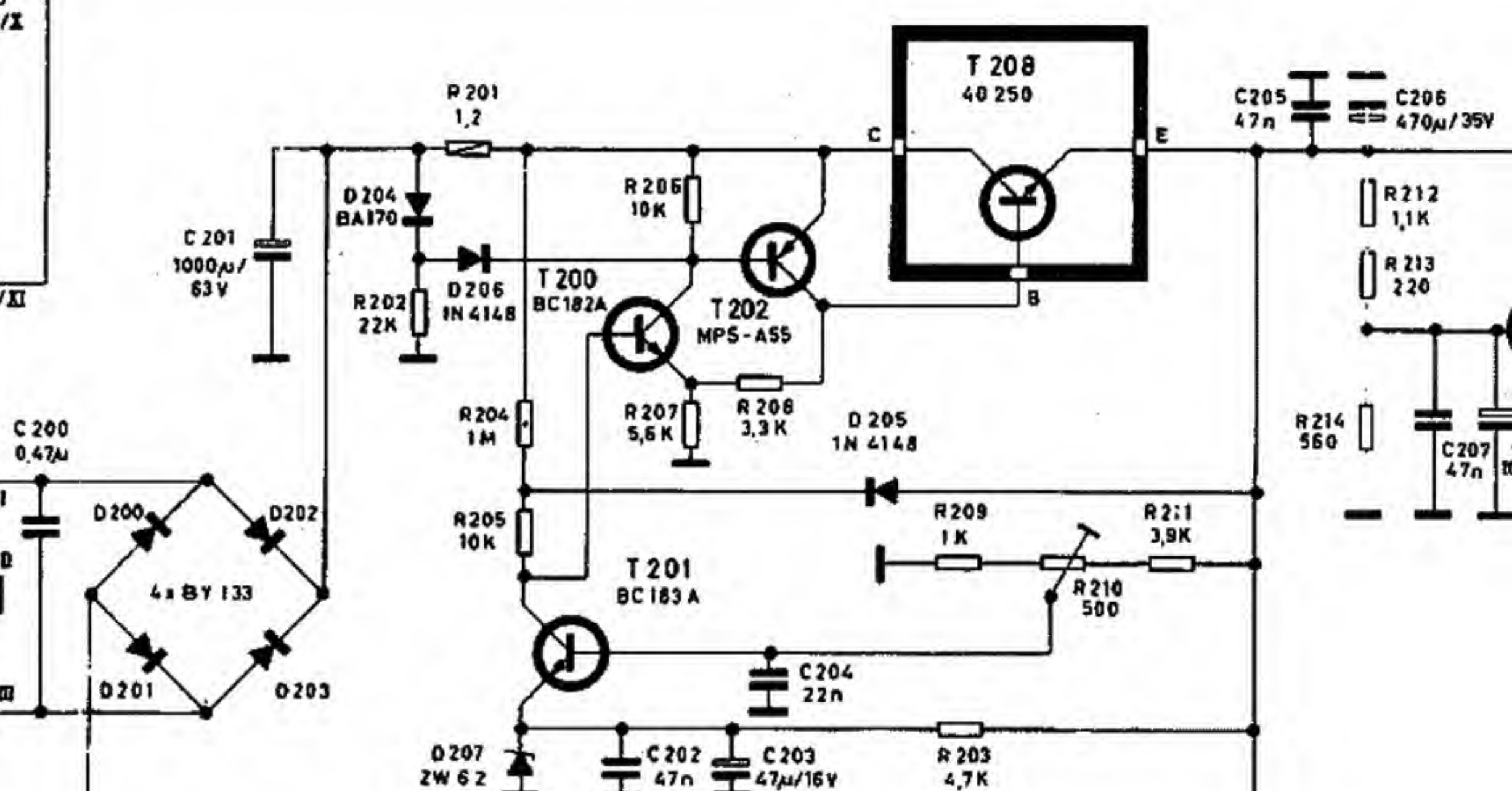
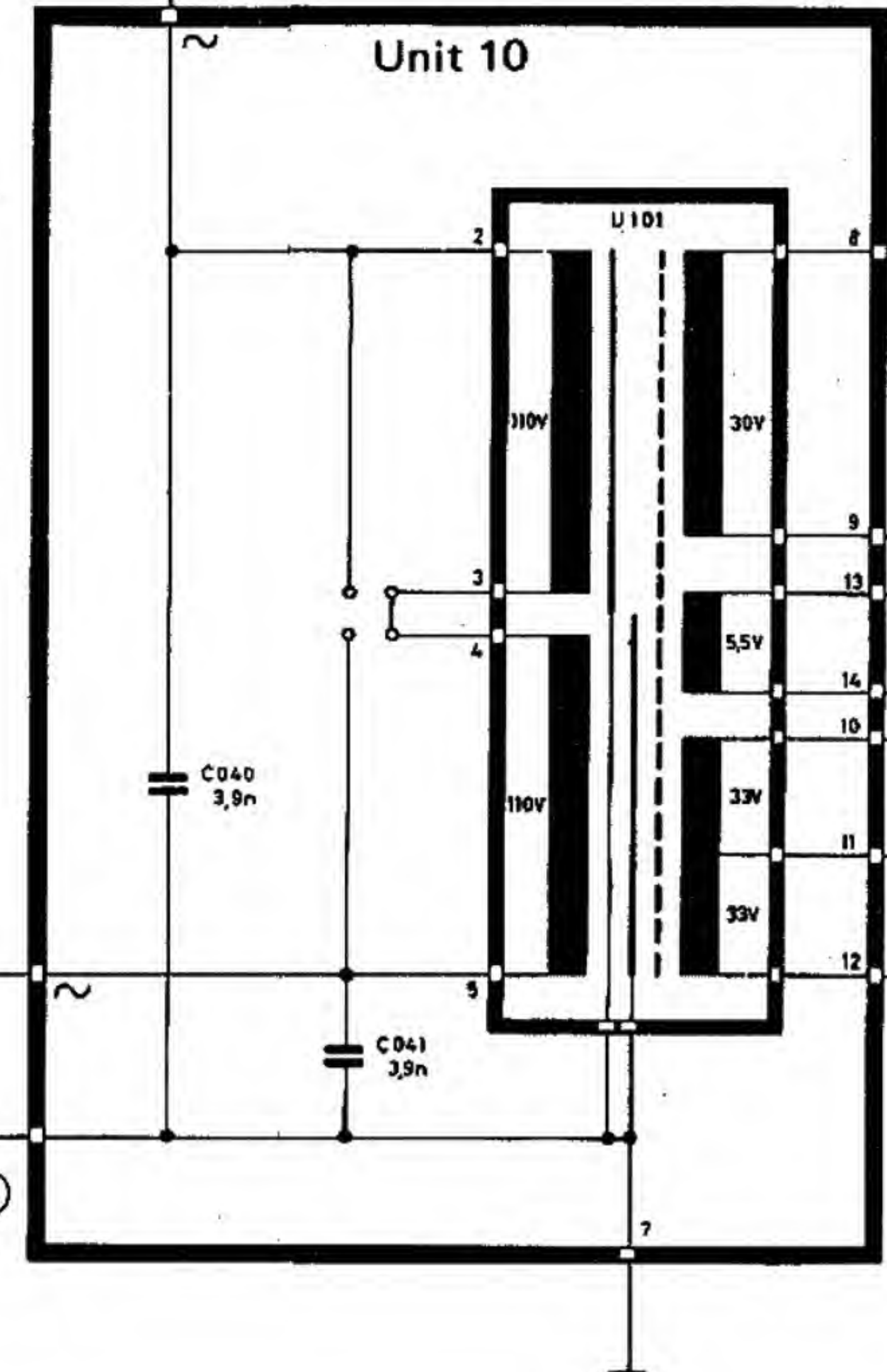
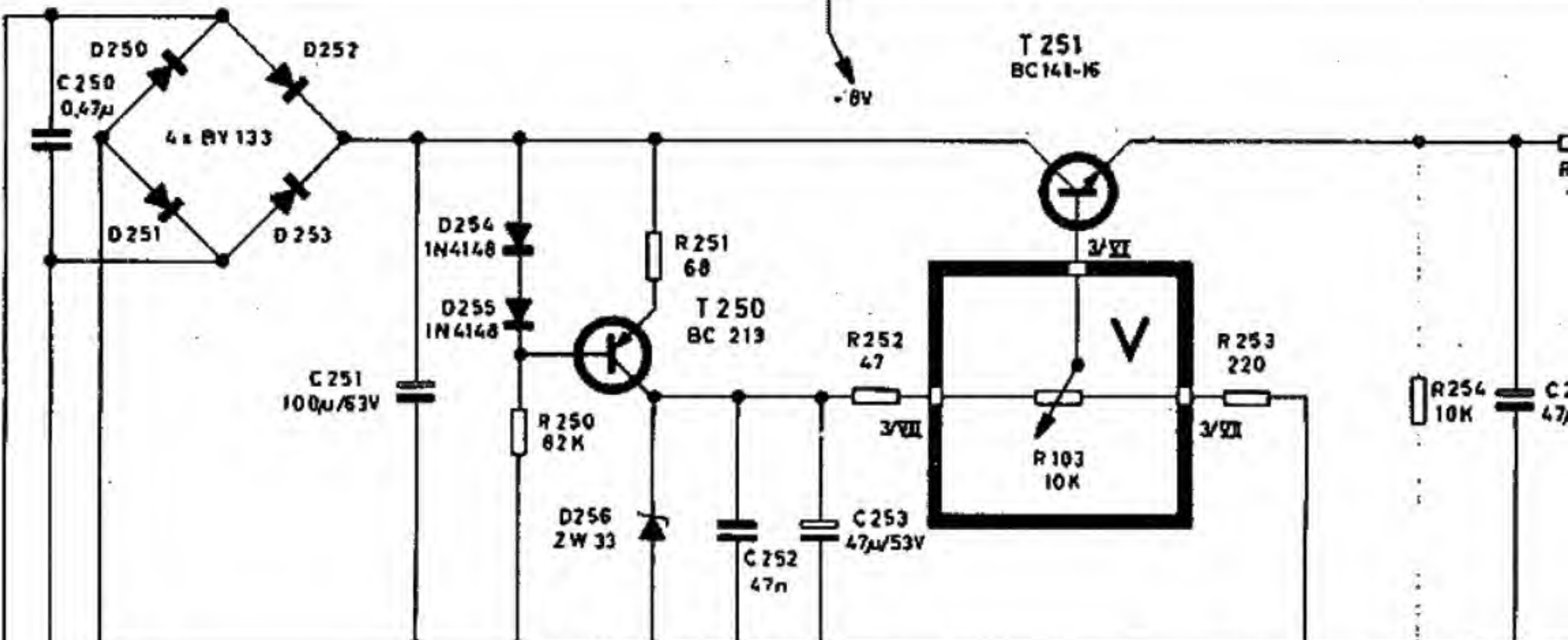
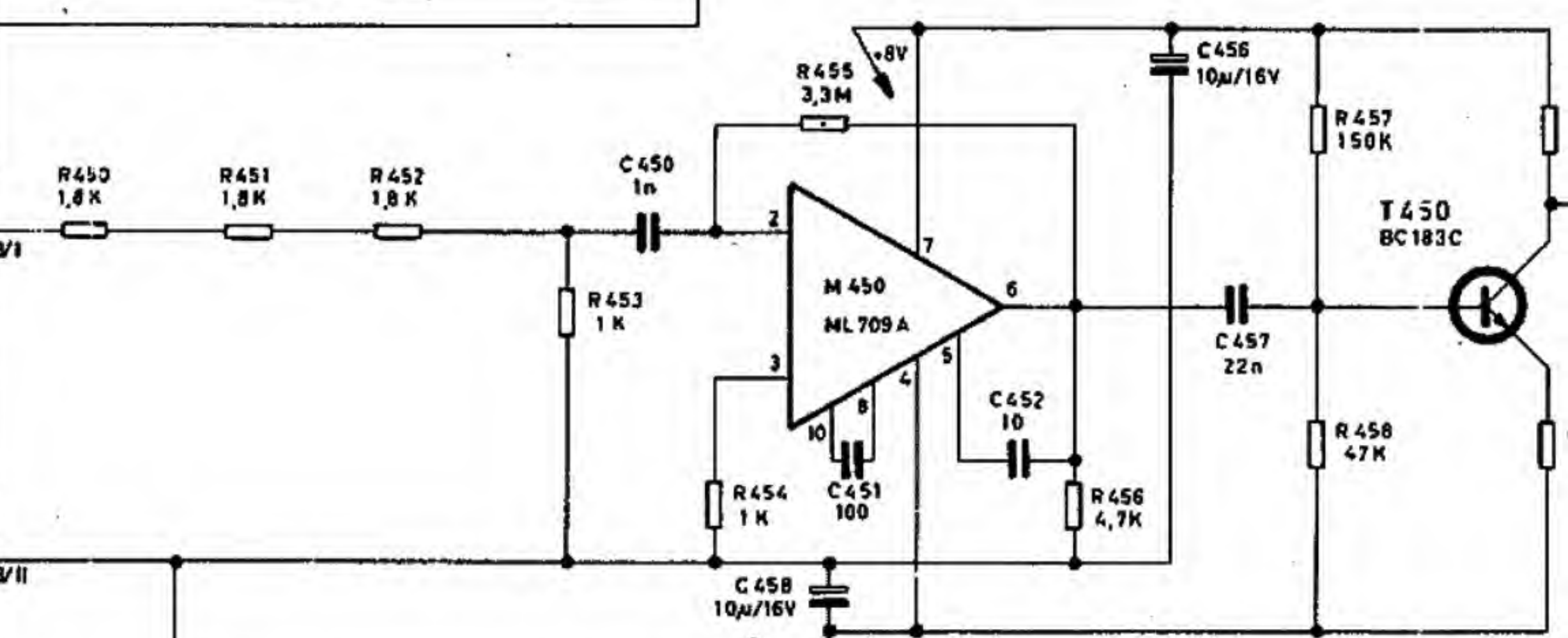
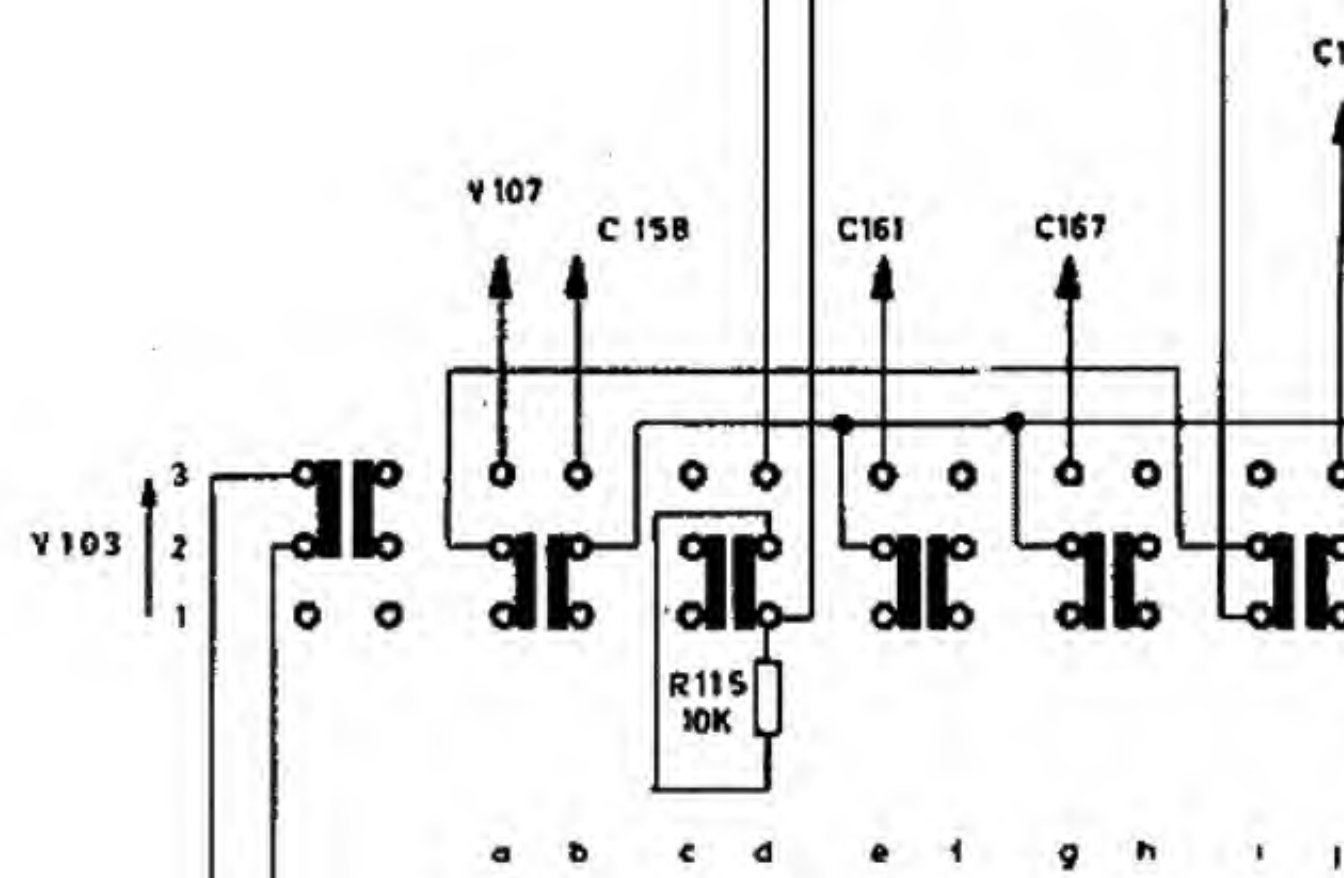
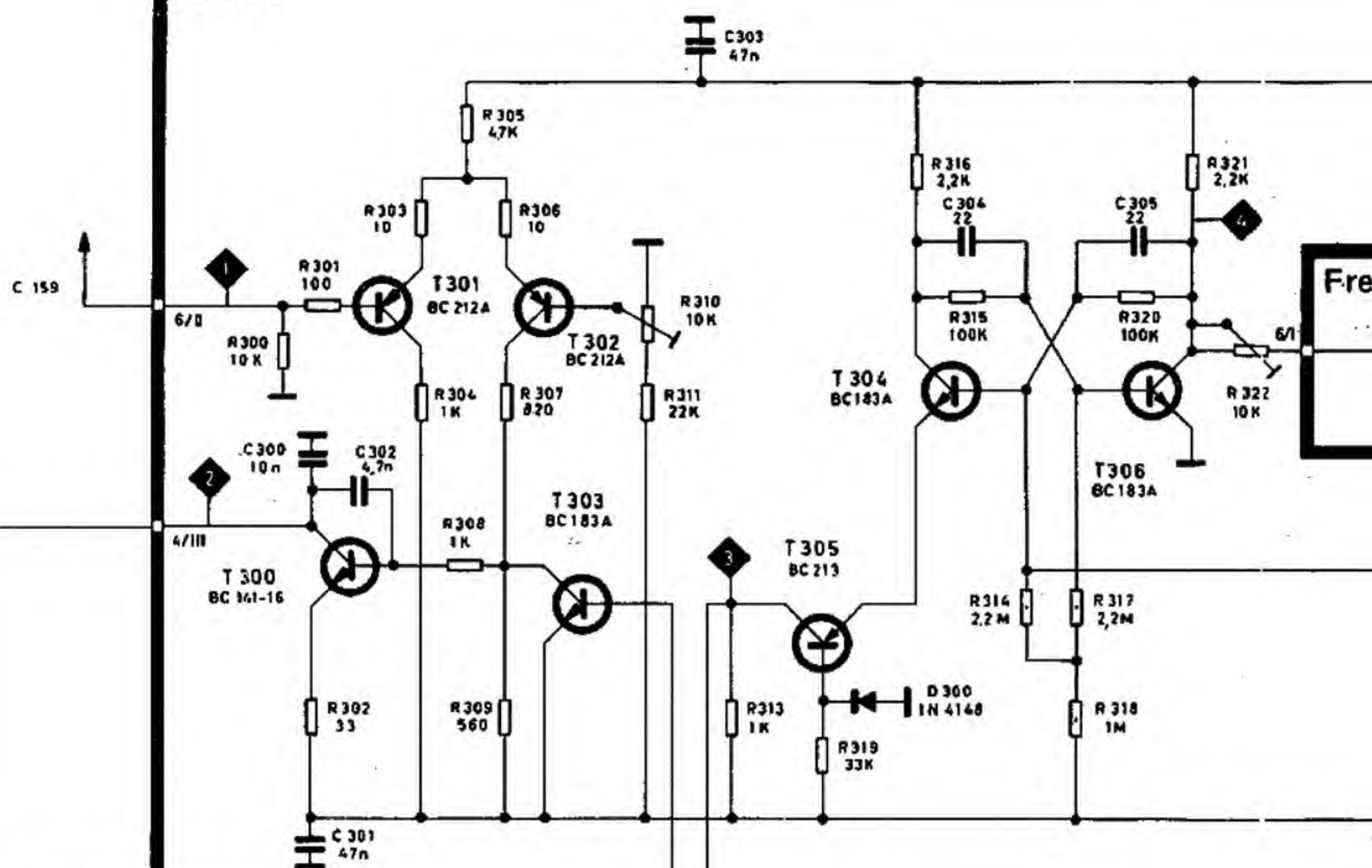
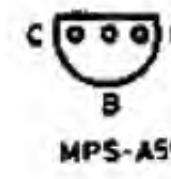
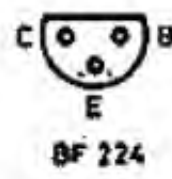
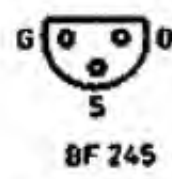
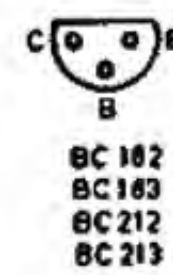
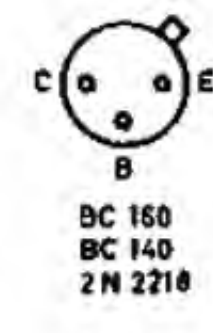
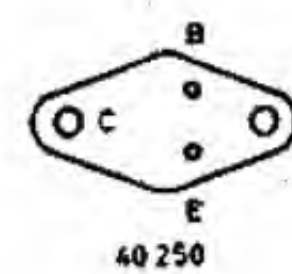
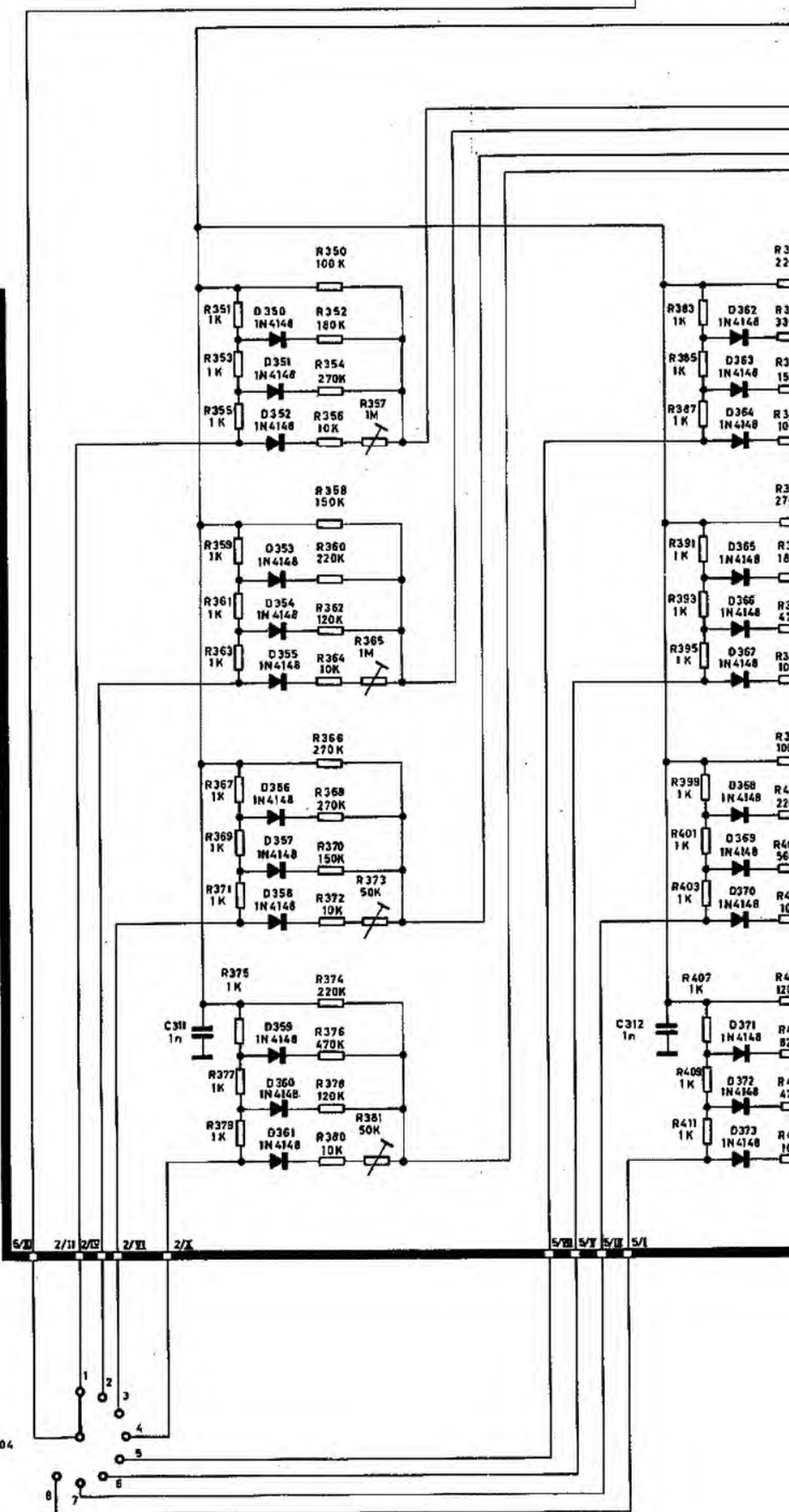
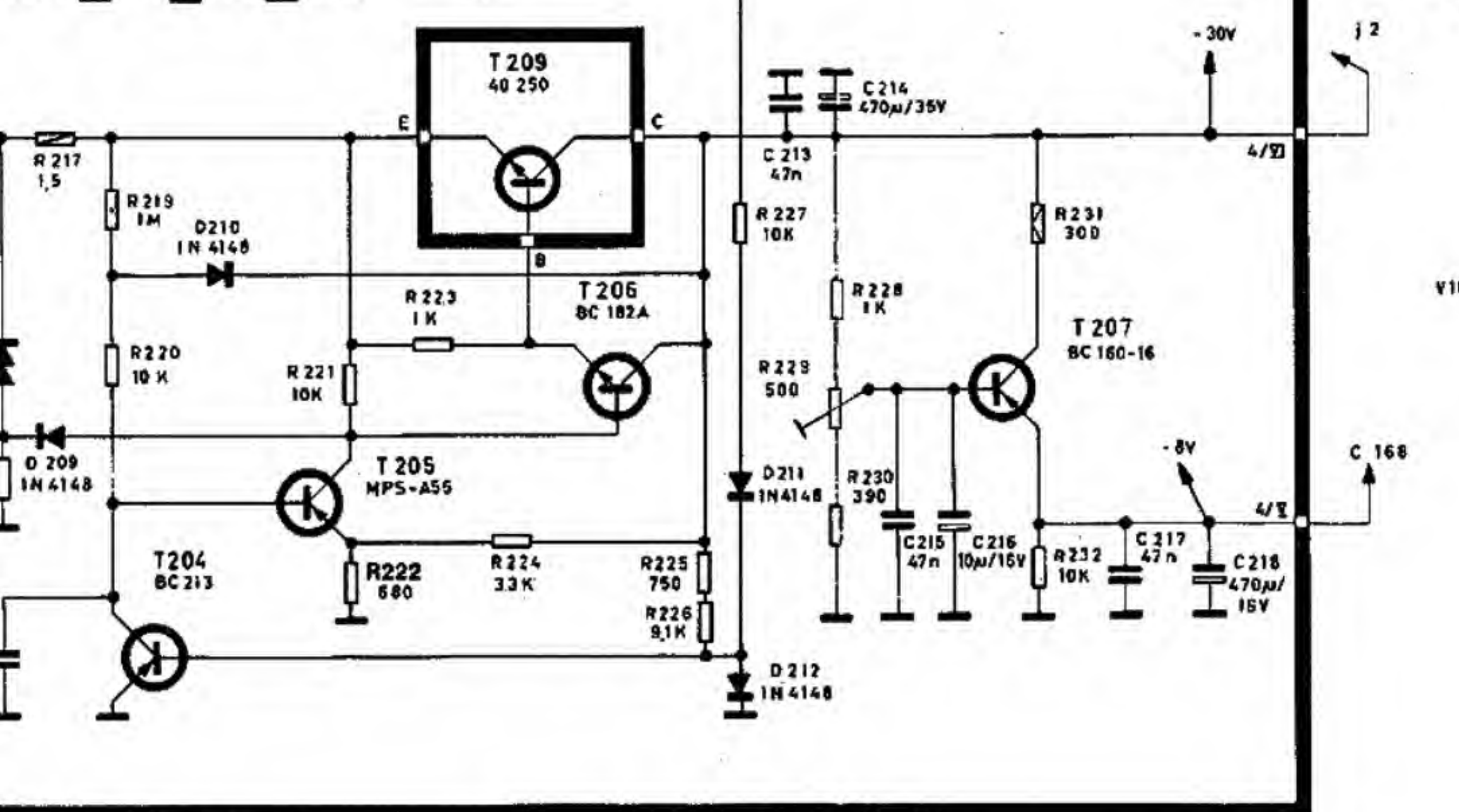


Unit 1





BC 160
 BC 140
 2 N 221 B

BC 182
 BC 183
 BC 212
 BC 213

BF 245

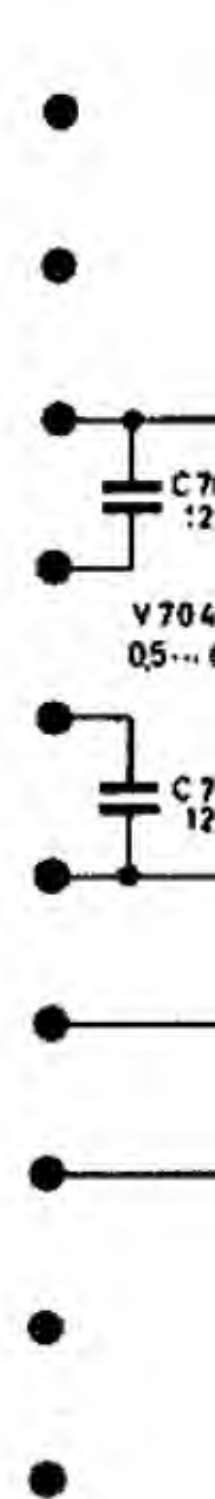
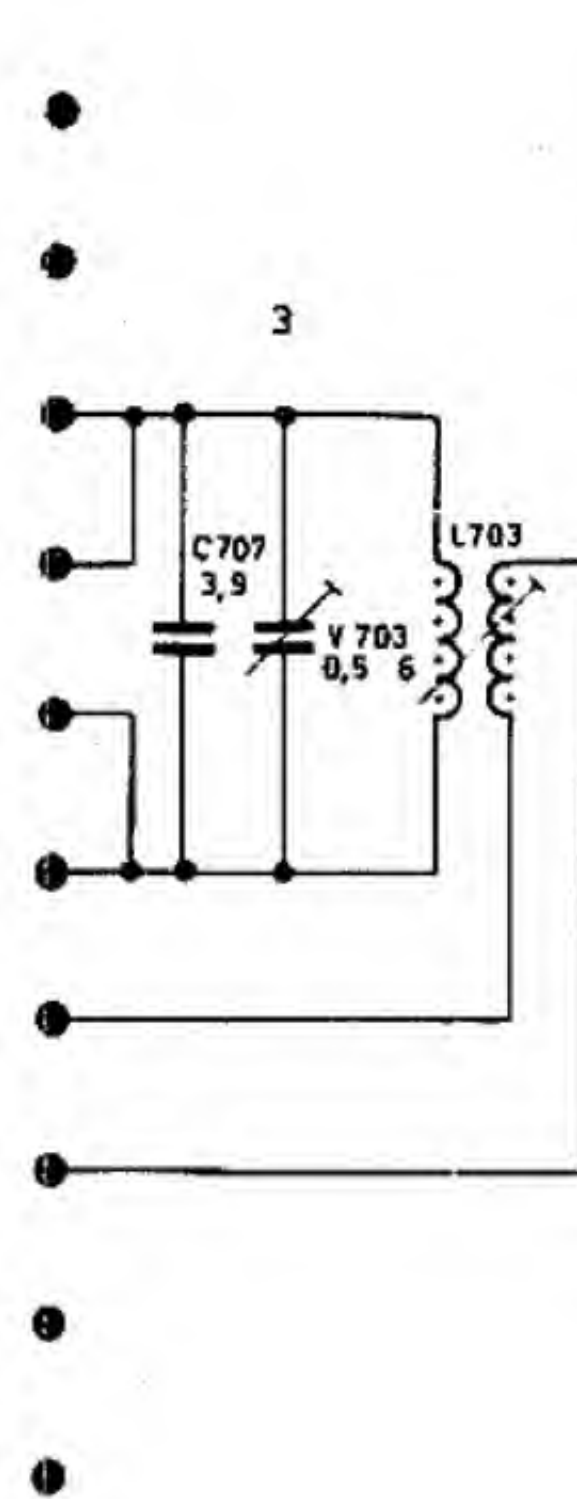
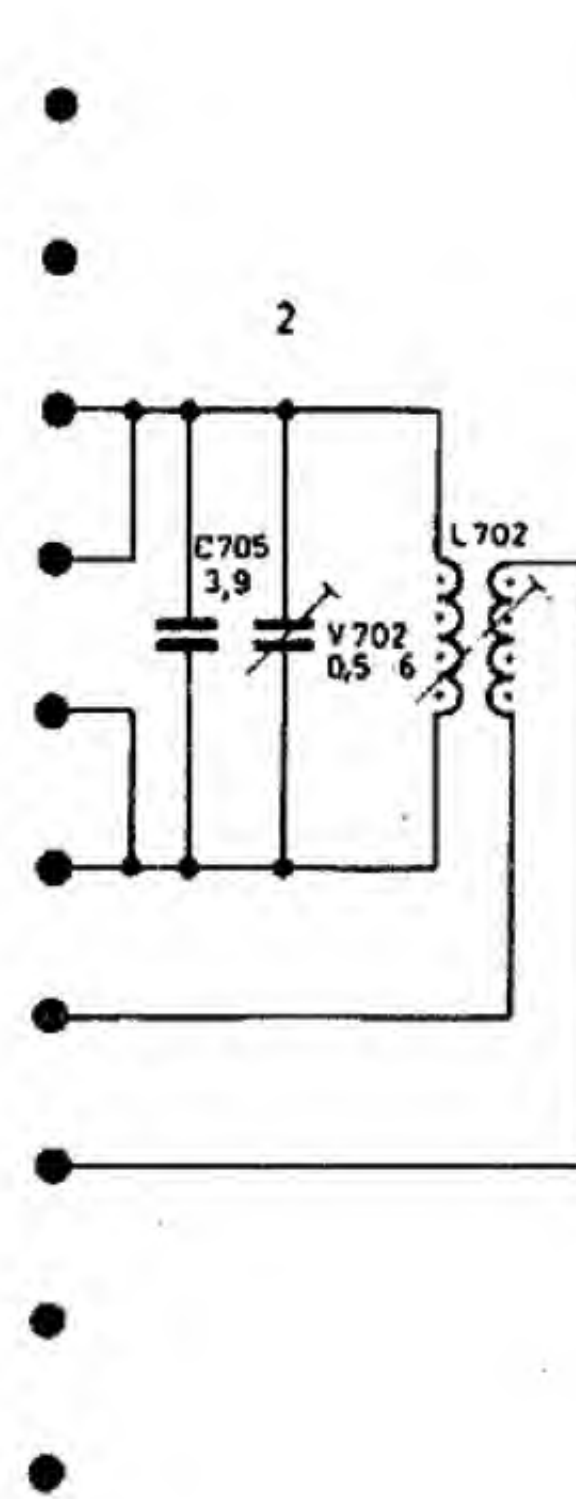
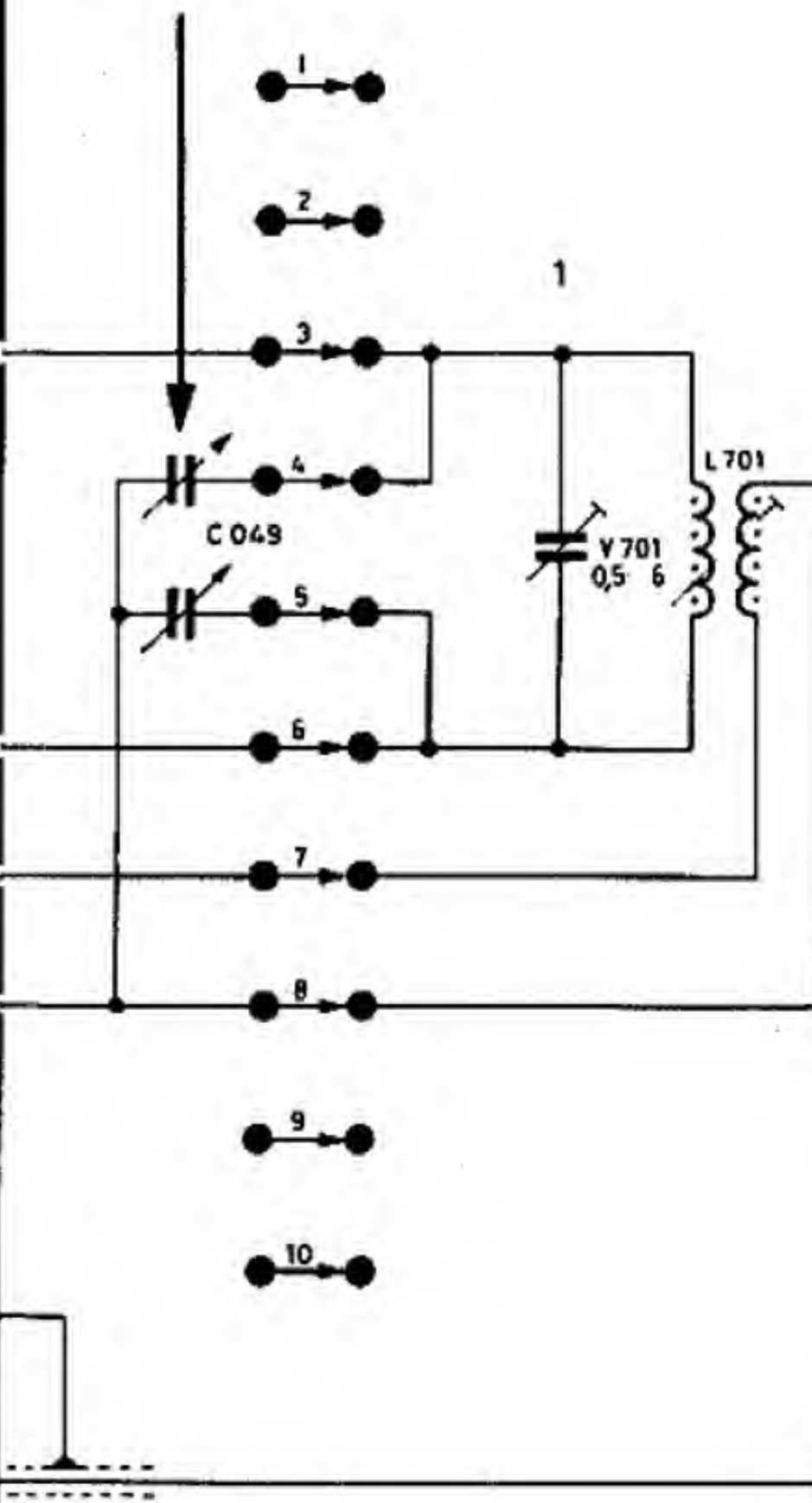
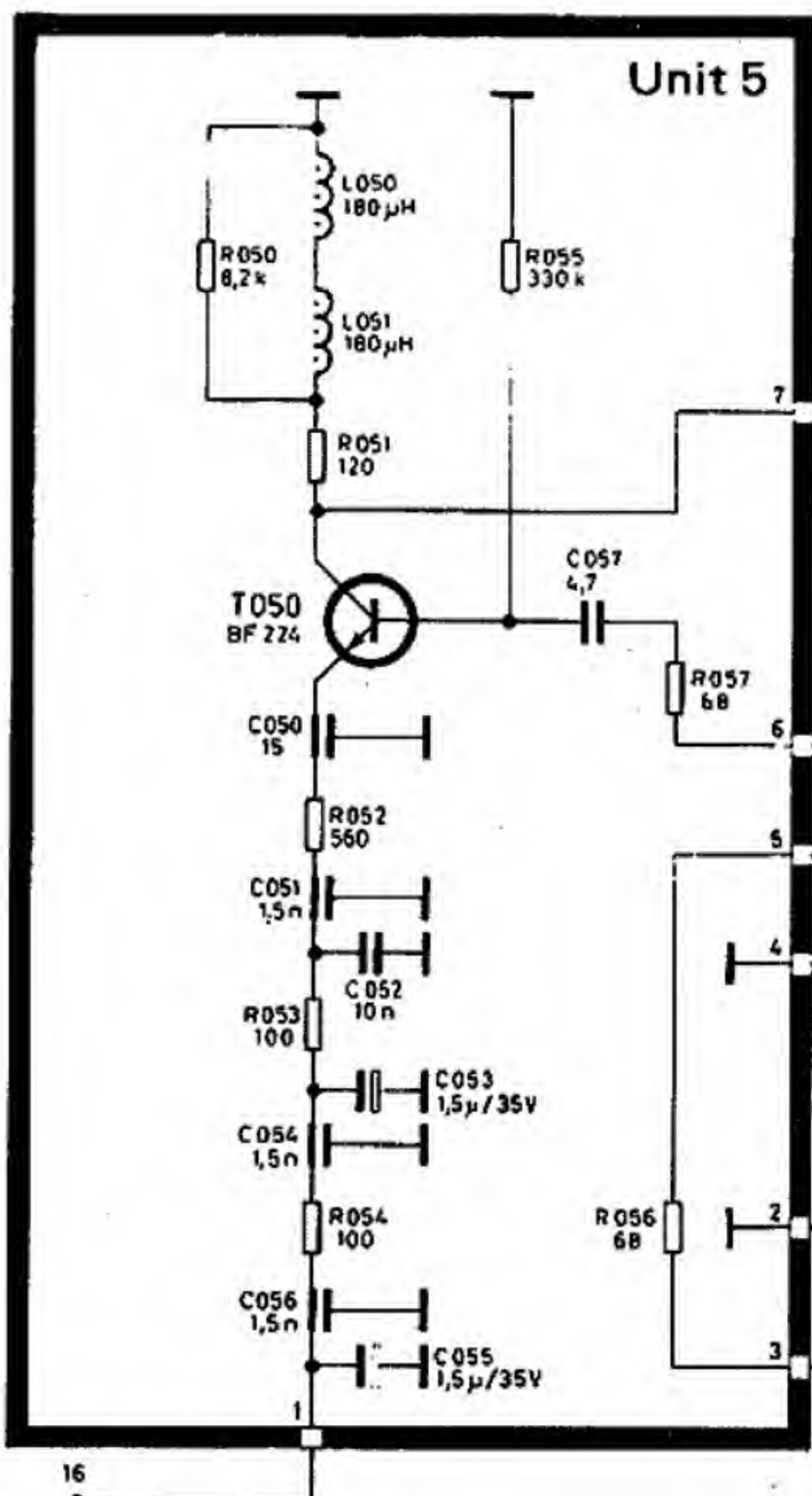
BF 224

MPS-A55

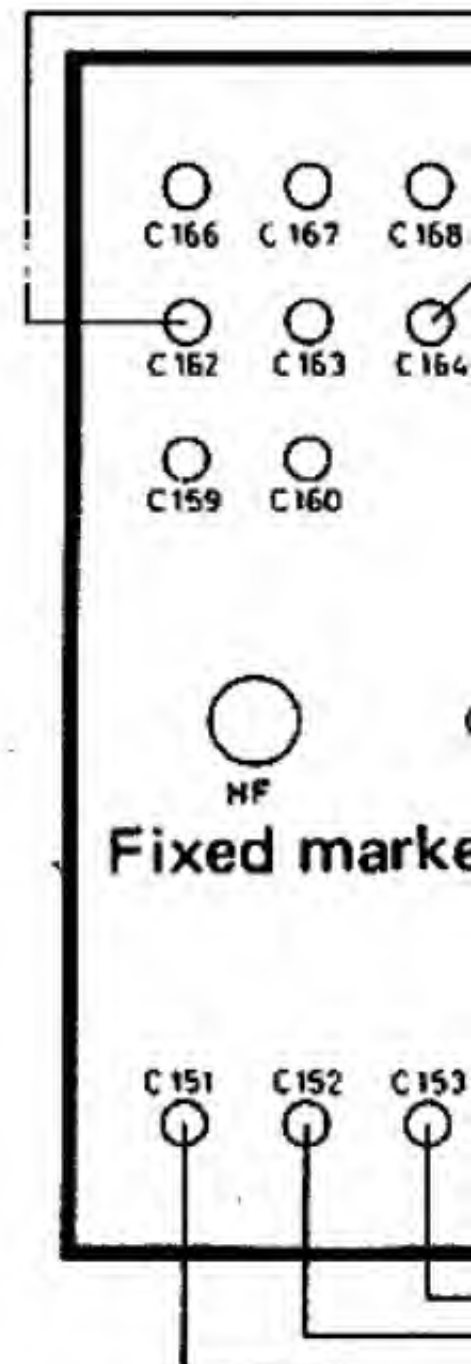
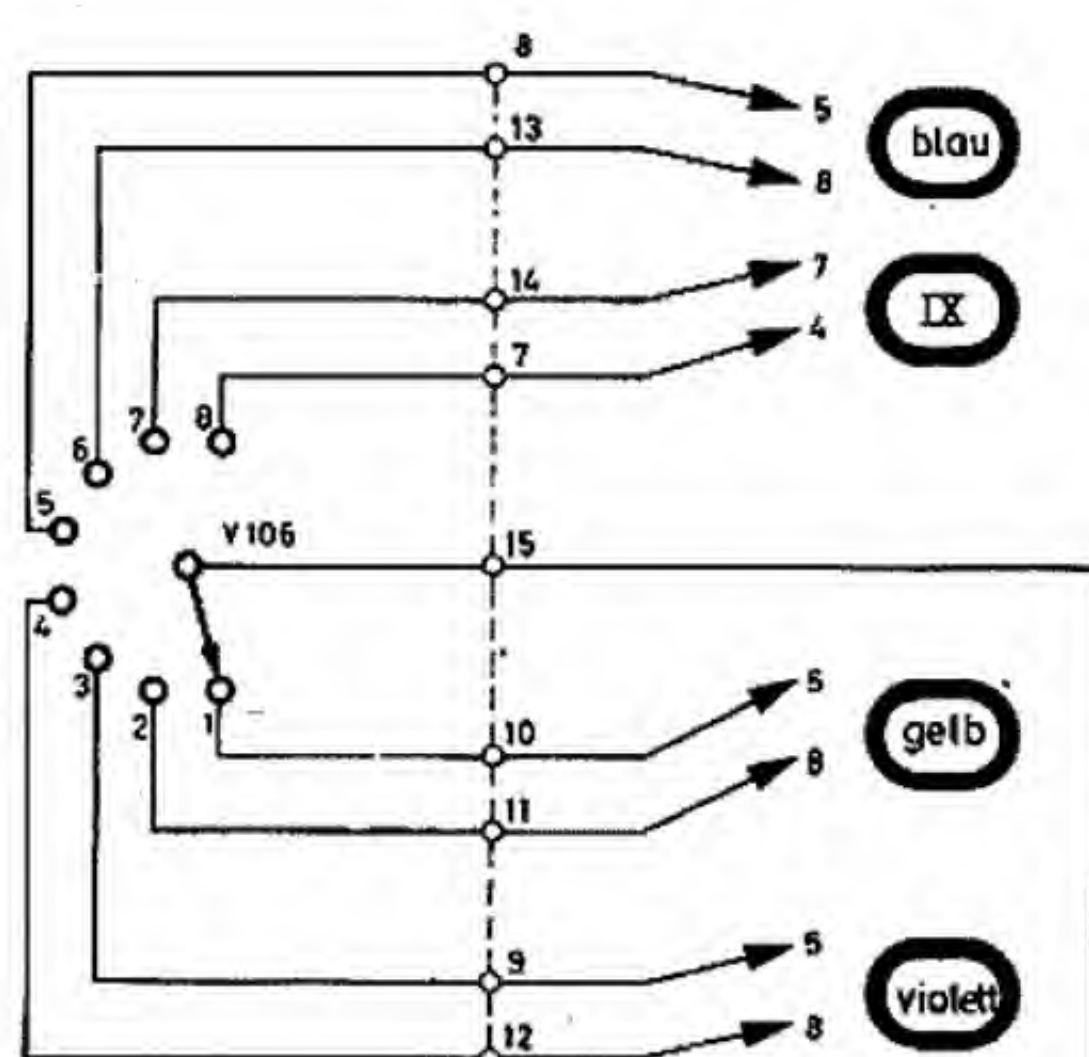
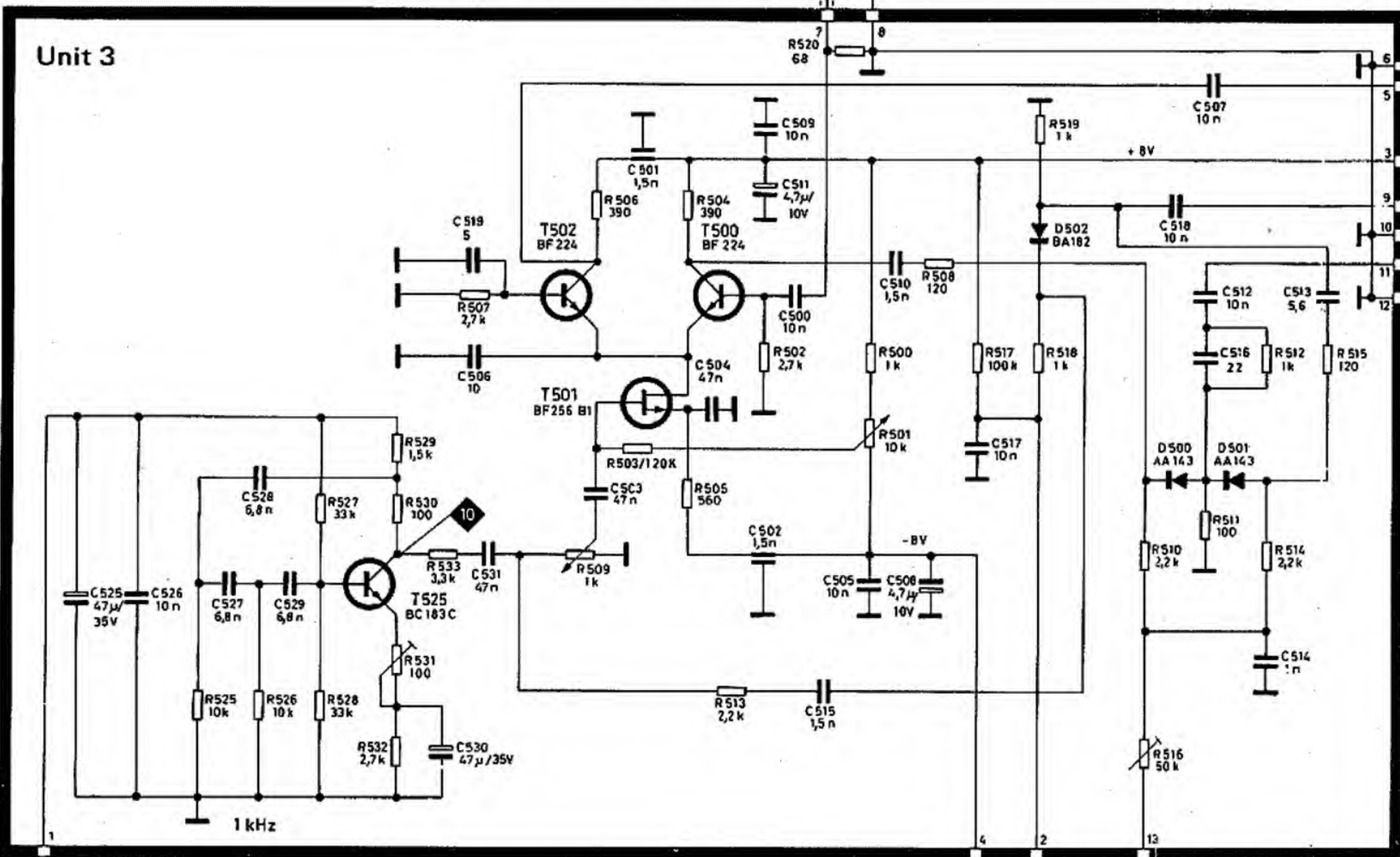
— 0,5 W
 — 1,33 W
 — 4 W

Unit 5

Marker frequency



Unit 3



IX 7/VI

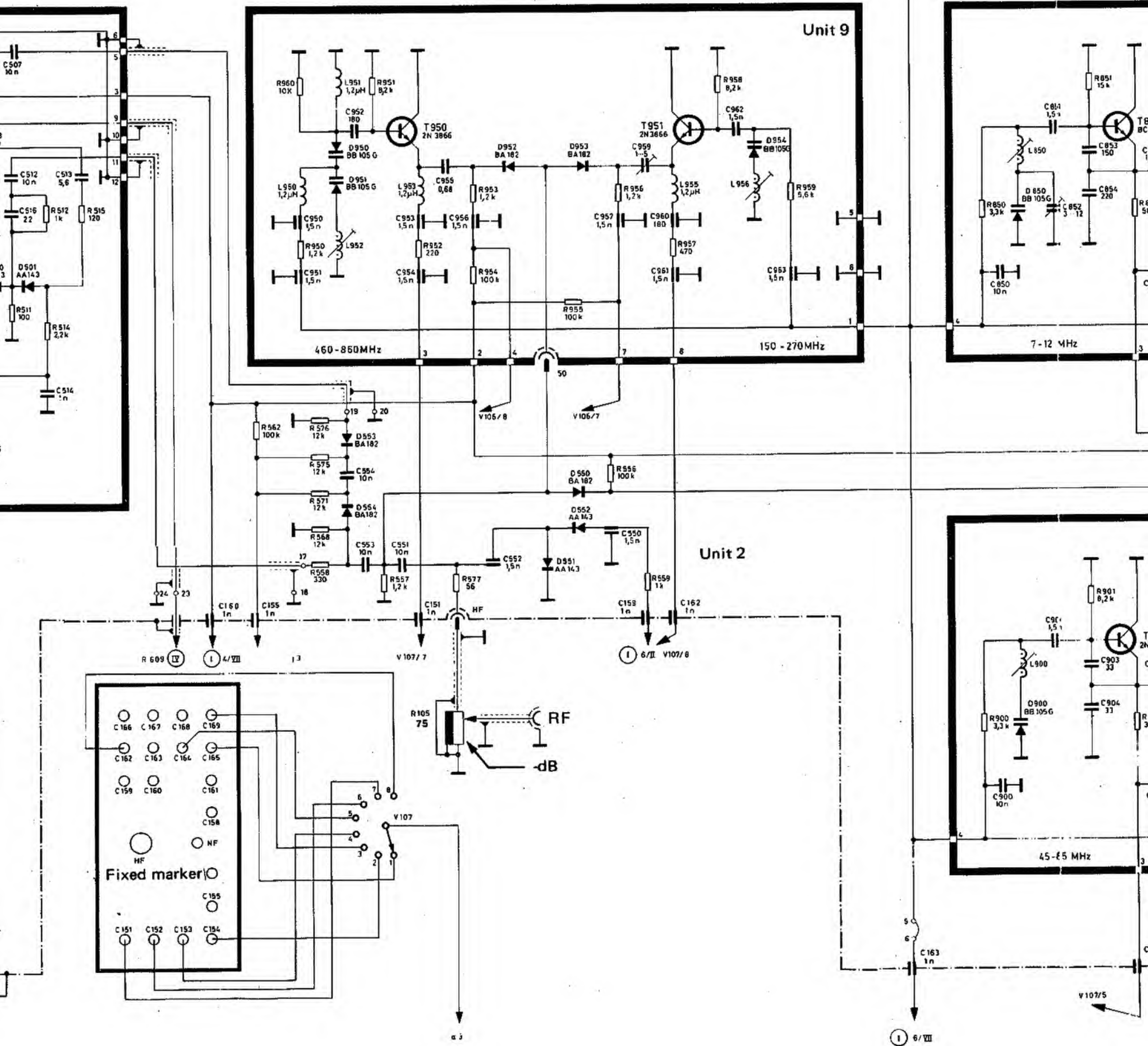
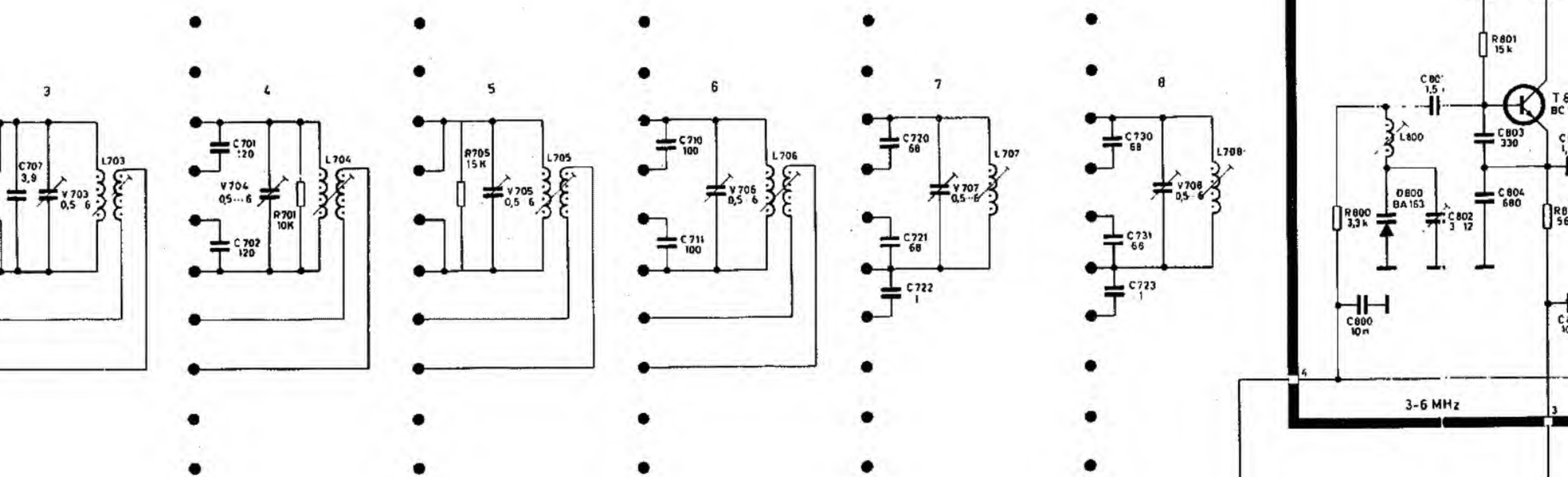
b 3

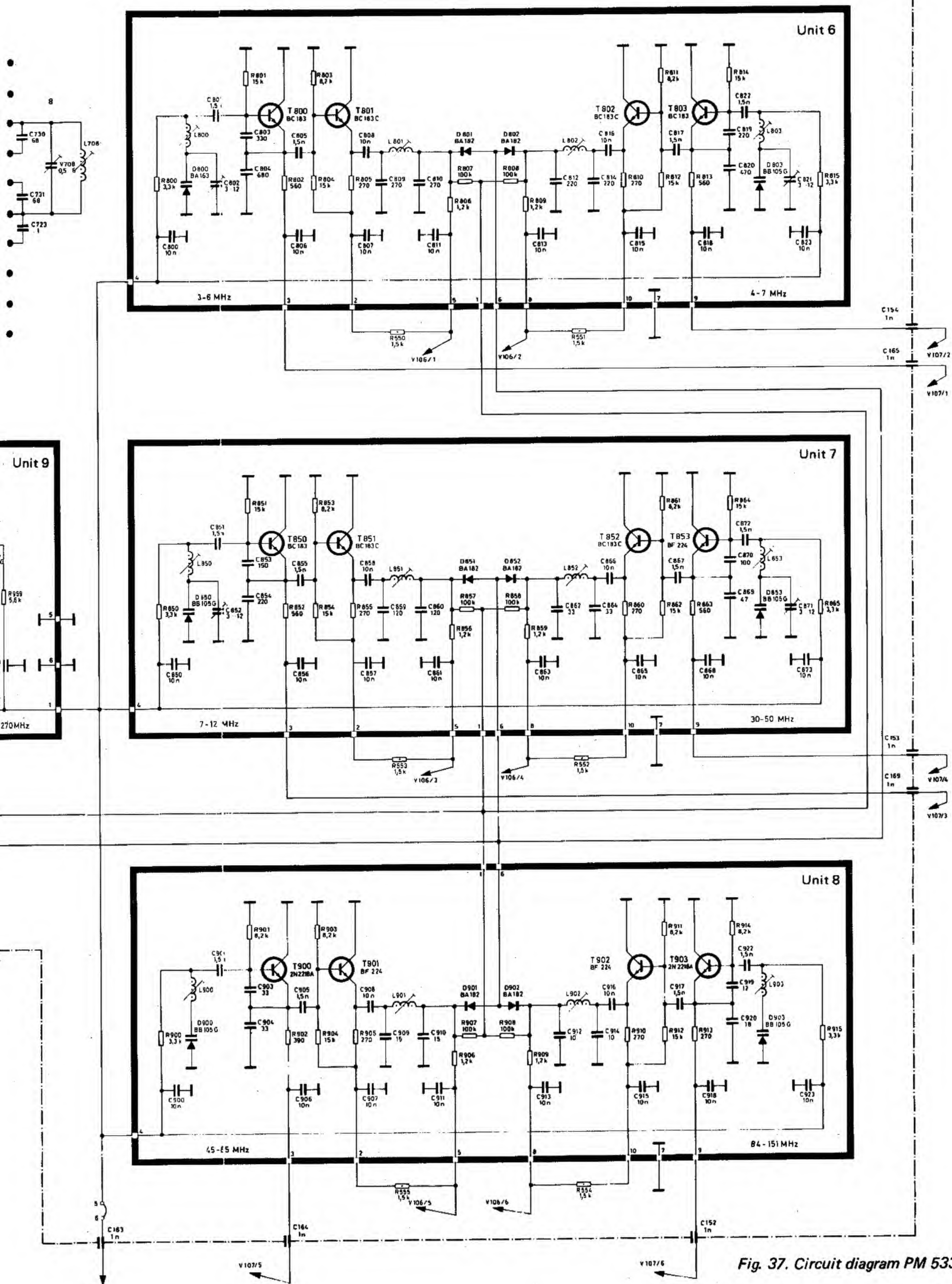
I 4/IX

g 3

I 3/II

Fixed marker





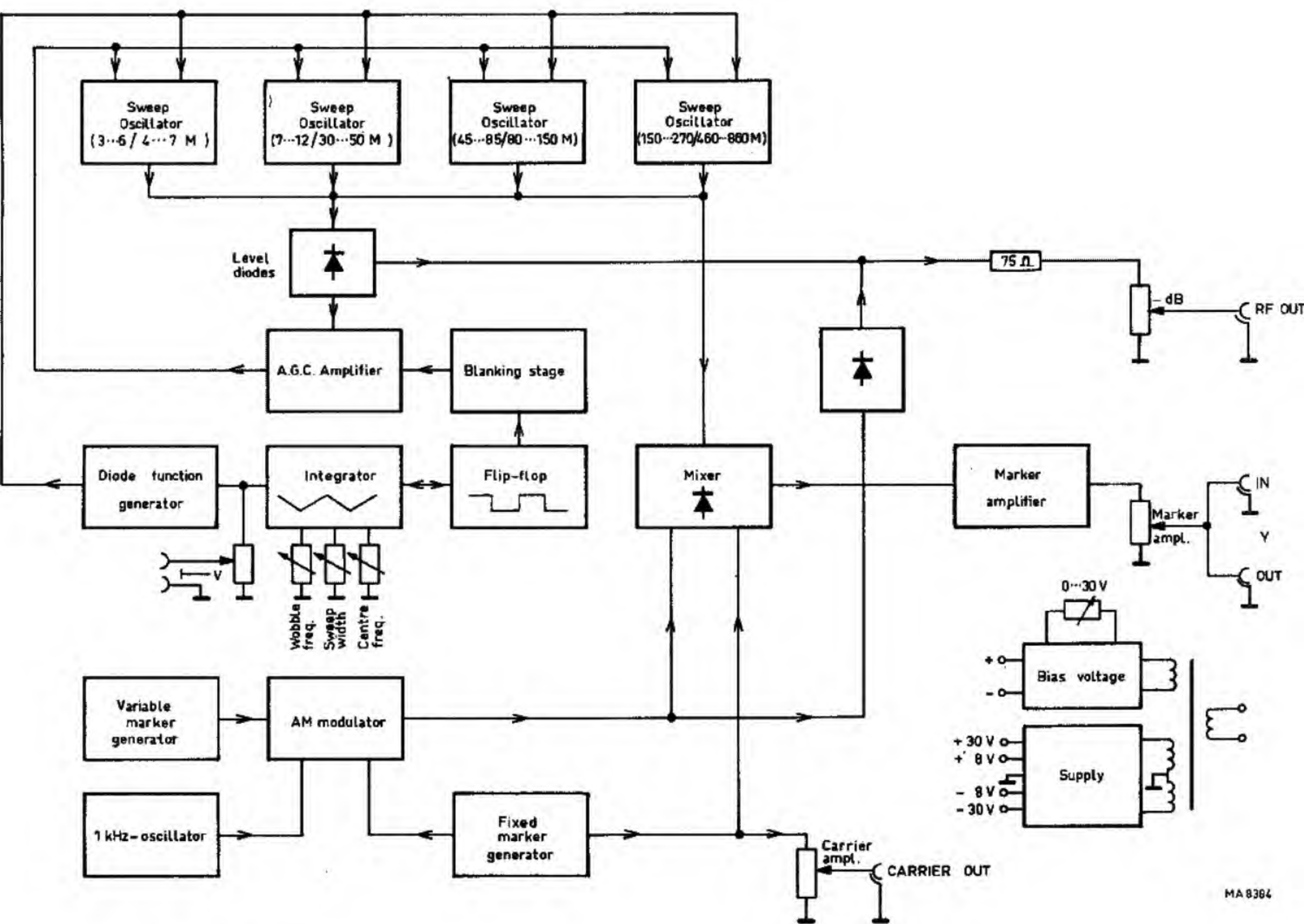


Fig. 1. Block diagram

1. General

1.1. INTRODUCTION

TV Sweep Generator PM 5334 is a versatile generator for TV test- and alignment purposes.

The complete television-, FM- as well as IF ranges are covered by using 8 individual frequency ranges, viz.

1. 3-6 MHz, T.V. sound and chroma IF
2. 4-7 MHz, T.V. sound and chroma IF
3. 7-12 MHz, FM IF
4. 30-50 MHz, T.V. picture IF
5. 45-85 MHz, T.V. band I
6. 85-150 MHz, FM band II
7. 150-270 MHz, T.V. band III
8. 460-860 MHz, T.V. band IV and V

The instrument has a large scale easy to read, with special markers required for those frequencies used during alignment of T.V. sets.

The sweep width is continuously adjustable and covers the complete selected scale range, thus enabling measurements on wide-band amplifiers. The sweep frequency is adjustable between 8 and 50 Hz.

The variable marker can be modulated with a 1 kHz sine-wave or with a fixed marker (5.5 MHz, 10.7 MHz or 38.9 MHz).

The output voltage is stabilized and continuously adjustable up to -80 dB in a load of $75\ \Omega$.

1.2. TECHNICAL DATA

Properties expressed in numerical values with tolerances are guaranteed by the factory.

Numerical values without tolerances serve only for information and represent the properties of an average instrument.

1.2.1. Sweep frequency generator

Frequency range	3 MHz ... 860 MHz divided in 8 ranges 3 ... 6 MHz 4 ... 7 MHz 7 ... 12 MHz 30 ... 50 MHz 45 ... 85 MHz 85 ... 150 MHz 150 ... 270 MHz 460 ... 860 MHz
Principle	Individual oscillators; sweeping by varicap diodes
Sweep frequency	Sawtooth, adjustable from 8 Hz ... 50 Hz
Blanking	Duty cycle 1:1; blanking can be switched off
Sweep width	Continuously adjustable; maximum width covers the complete selected frequency range
Centre frequency	Continuously adjustable
Output connector	BNC

RF output voltage (in 75 Ω load)	200 mV ± 1 dB for ranges up to 150 MHz 150 mV ± 1 dB for ranges 150 MHz ... 860 MHz electronically stabilized
Amplitude RF OUT	
for max. sweep width	±1 dB in ranges up to 150 MHz ±3 dB in ranges 150 MHz ... 860 MHz
at 50 MHz sweep width	±1 dB in range 150 MHz ... 270 MHz ±2 dB in range 460 MHz ... 860 MHz
RF attenuator	Continuously adjustable from 0 to 80 dB
Sawtooth	Maximum 15 V _{pp} , adjustable (X deflection for oscilloscope)
1.2.2. Variable marker generator	
Variable marker	In ranges up to 270 MHz at fundamental frequency In range 460 ... 860 MHz on second harmonics
Frequency accuracy	±1×10 ⁻² in the ranges up to 150 MHz ±1.5×10 ⁻² in the ranges 150 MHz ... 860 MHz
Temperature stability	±2.5×10 ⁻⁴ per °C
Output voltage (in 75 Ω)	100 mV _{pp} in the ranges up to 150 MHz 50 mV _{pp} in range 150 ... 270 MHz 20 mV _{pp} in range 460 ... 860 MHz The marker generator can be connected to the RF sweep frequency output by means of button MARKER RF .
Mode of operation	Unmodulated Amplitude modulated with 1 kHz Modulated with permanent markers at 5.5 MHz, 10.7 MHz or 38.9 MHz
Scale	Drum scale, length 220 mm
Marker knob	Coarse/fine ratio 1:3
1.2.3. Fixed marker generator	
Fixed marker frequency	5.5 MHz 10.7 MHz 38.9 MHz
Frequency stability	±0.1 %
Temperature stability	±0.3×10 ⁻⁴ per °C
Fixed marker output level	250 mV in 75 Ω continuously attenuable from 0 to > 25 dB
principle	– Marker mixing, AF beat frequency markers – Marker addition via loop through BNC connectors – Marker amplitude 2 V _{pp} minimum – Attenuation adjustable with loop through connectors 1 dB
1.2.4. Bias voltage source	
Output voltage	floating, adjustable between 0 and 30 V
Hum voltage	1 mV _{pp}
Internal resistance	< 500 Ω
Maximum current	50 mA
1.2.5. Supply	
Mains voltage	220 V or 110 V

Voltage deviation	+10 %, -10 %
Frequency	50 or 60 Hz
Consumption	32 VA

1.2.6. Temperature

Ambient temperature	0 - 40 °C
---------------------	-----------

1.2.7. Mechanical data

Dimensions	Height	177 mm
	Width	328 mm
	Depth	260 mm
Weight		10 kg

1.3. ACCESSORIES

1.3.1. Included as standard

- Mains cable
- Manual

1.3.2. Optional

- Cable BNC → two 4 mm plugs, PM 9072
- Cable BNC → BNC, PM 9075
- Cable BNC → 10:1 probe, PM 9336
- Radio cable BNC → impedance transformer 75 Ω /300 Ω , PM 9337
- T.V. cable BNC → T.V. connector 75 Ω , PM 9538
- T.V. cable BNC → impedance transformer 75 Ω /300 Ω , PM 9539

1.4. DESCRIPTION OF THE BLOCK DIAGRAM

Sweep frequency oscillator

Each frequency range has its own sweep frequency oscillator. The frequency may be varied with varicap diodes which are controlled with a distorted sawtooth from the diode function generator.

The output level of the oscillators is electronically stabilized by using an automatic gain control amplifier. At this output the signal is blanked during flyback of the sawtooth, thus generating the zero-line in the waveform of the sweep frequency.

Variable marker generator

The variable marker generator is a Colpitts oscillator, the frequency of which can be varied by a variable capacitor. This generator is also used as oscillator for the signal generator. The UHF range is marked with the third harmonic of the marker oscillator.

AM modulator

In the AM modulator the RF signal of the variable marker oscillator can be amplitude-modulated with a 1 kHz signal. In mode SWEEP the marker-generator signal is also modulated in this stage with the RF signal of the fixed marker generator to generate the side markers.

1 kHz generator

The 1 kHz generator, functioning as a phase-shifter, supplies a 1 kHz signal for modulation of the variable marker generator.

Mixer

Depending on the mode of operation the signals from sweep generator, AM modulator and fixed marker generator are fed to a diode mixer. Mixing of these signals results in beat-frequency markers which are applied to the marker amplifier.

In mode SWEEP the demodulated signal can be marked with this beat-frequency signal and with the frequency of the fixed marker generator by connection to interconnected sockets Y-IN and Y-OUT.

During operation as signal generator the scale can be calibrated and the frequency setting of the generator can be checked by zero beat checking with the fixed marks on an oscilloscope.

Fixed marker oscillator

The fixed marker generator is a Clapp type circuit, generating frequencies of 5.5 MHz, 10.7 MHz and 38.9 MHz in order to mark the sweep. The frequency is also available as an RF signal at connector CARRIER OUT.

If necessary, adaptation to local requirements (different sound-visio distance of 5.5 MHz or different i.f. frequency of 38.9 MHz) is possible (see chapter 2.2.5.).

AGC Amplifier and blanking stage

The output voltage of the sweep oscillators is controlled in order to drive the sweep output signal.

For this purpose an AGC amplifier is used. The output level of the oscillator is checked by level diodes.

The same amplifier also comprises a blanking stage in order to blank the sweep signal during flyback.

Sawtooth generator

The sawtooth generator consists of an integrator and a flip-flop. The square-wave signal from the flip-flop is converted into a linear sawtooth by the integrator.

The flip-flop and the integrator form a self-oscillating unit. The sawtooth frequency can be varied by changing the integration time-constant.

The control at the rear permits variation of the sawtooth frequency between 8 Hz and 50 Hz.

The sawtooth is used to drive the diode function generator. The signal is also available at sockets SAWTOOTH FREQUENCY OUT and \perp for horizontal deflection of an oscilloscope.

The amplitude of the sawtooth can be adjusted by a control at the rear.

Diode function generator

The function of the diode function generator is to shape the sawtooth so that a linear frequency change - corresponding to the X deflection of the oscilloscope - is obtained in the sweep oscillators when the varicap diodes are driven. The sawtooth drives a resistor-diode combination.

The diodes become conductive, one after the other, with the increasing sawtooth amplitude.

In this way resistors are switched successively in parallel with a common resistor. This results in a non-linear function in the form of a polygon trace which can be adapted to the varicap diode of any sweep oscillator by suitable dimensioning. The resistor-diode combination is different for every range and selected by the range switch.

Marker amplifier

The beat-frequency signal supplied by the diode mixer is amplified by the marker amplifier.

Certain band-pass characteristics, which determine the shape of the marker, are obtained by the circuitry of this amplifier. The amplitude of the markers may be adjusted by potentiometer MARKER AMPLITUDE.

Supply

The power supply provides four stabilized voltages (+30 V, +8 V, -8 V and -30 V). They are stabilized against temperature influences and mains fluctuations. A current limiting circuit to protect the circuits is built-in.

A stabilized floating bias voltage source adjustable between 0 - 30 V, is available.

This source can be used for e.g. bypassing the AGC circuits in TV sets or a small external circuit.

Instructions for use

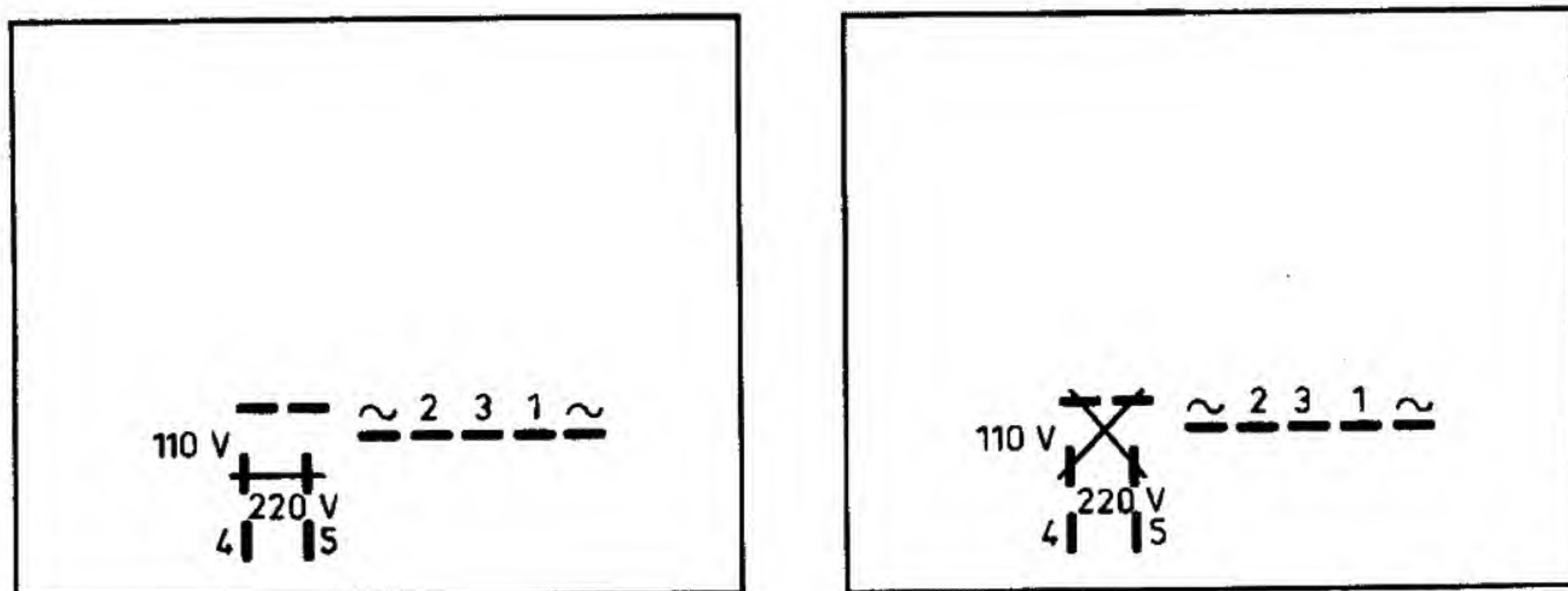
2.1. INSTALLATION

2.1.1. Mains supply

Upon delivery instrument PM 5334 is adjusted for a mains voltage of 220 V a.c. $\pm 10\%$.

If the instrument must be connected to a mains voltage of 110 V it first should be modified according to the following instructions.

- Remove the bottom plate.
- Modify the "transformer board" in accordance with Fig. 2.



MA 8386

Fig. 2. Transformer board

- Replace the 125 mA fuse, delayed action, by a fuse with a rating of 250 mA.

2.1.2. Fuse

Make sure that only fuses with the required current rating and of the specified type are used. The use of repaired fuses and the short-circuiting of fuse-holders is prohibited.

The rating of the mains fuse at the rear of the instrument should be:

- for 110 V mains: 250 mA, delayed action
- for 220 V mains: 125 mA, delayed action

2.1.3. Earthing

The instrument should be connected to a protective earth in accordance with the local safety regulations. This can be effected via the 3-core means lead. The mains plug should only be inserted in a socket outlet provided with a protective earth contact, the protective action of which is not cancelled by the use of an extension card or device which does not have a protective conductor.

Note

In most T.V. receivers equipped with valves, the heaters are series-connected; in this case, one pole of the mains has been connected directly to the chassis. In other sets a Graetz circuit is used in the power supply. The chassis is at 220 V, no matter how the mains cable is connected.

Therefore, connect the receiver to the mains via a separating transformer only.

2.2. OPERATION

2.2.1. Switching on


After connection to the mains and earthing, the instrument is ready for use. By means of button POWER the instrument is switched on, indicated by the green pilot lamp left to the button.

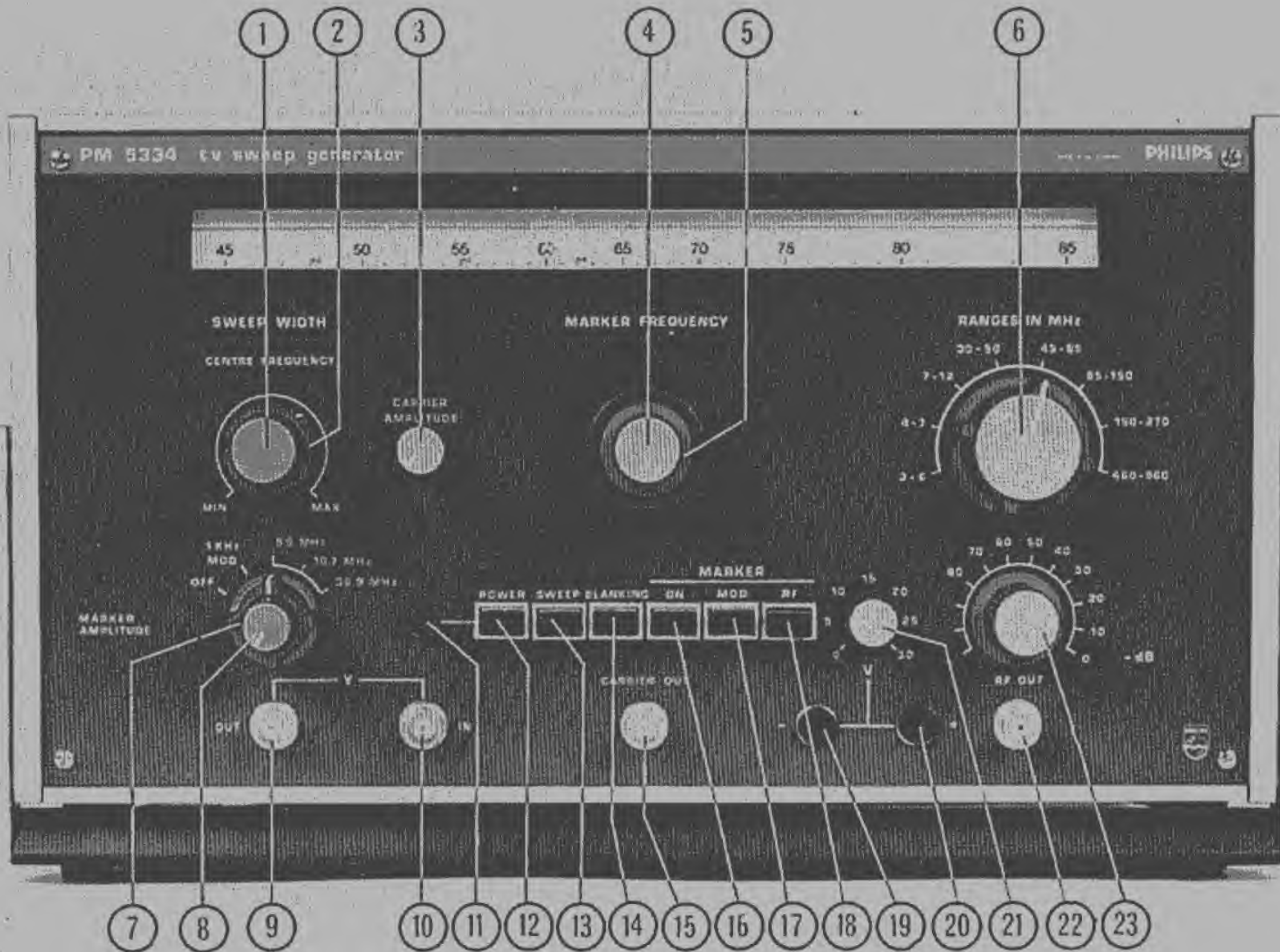
2.2.2. Controls and sockets at the front (Fig. 3)

<i>Item</i>	<i>Description</i>	<i>Function</i>
1	CENTRE FREQUENCY	Control to adjust the centre frequency within the selected range by item 6
2	SWEEP WIDTH	Control to adjust the width of the sweep
3	CARRIER AMPLITUDE	Control to adjust the amplitude of the carrier (5.5 MHz, 10.7 MHz or 38.9 MHz) available at connector CARRIER OUT (item 15)
4 } 5 }	MARKER FREQUENCY	Fine tuning of the marker-generator frequency Coarse tuning of the marker-generator frequency
6	RANGES IN MHz	Switch to select the range of the marker-frequency
7	MARKER switch	5-Position mode switch – OFF : The (variable) marker frequency is unmodulated – 1 kHz MOD.: The marker frequency is AM modulated with 1 kHz; modulation depth 30 % – 5.5 MHz : The marker frequency is modulated with a fixed marker at 5.5 MHz – 10.7 MHz : The marker frequency is modulated with a fixed marker at 10.7 MHz – 38.9 MHz : The marker frequency is modulated with a fixed marker at 38.9 MHz
8	MARKER AMPLITUDE	Control to adjust the amplitude of the markers, the variable as well as the fixed ones (5.5 MHz, 10.7 MHz or 38.9 MHz)
9	Y-OUT	Output of band-pass curve, supplied via connector Y-IN, added with markers
10	Y-IN	Input for band-pass curve, taken from the circuit under test, in order to add markers
11 } 12 }	POWER	Green pilot lamp to indicate that the instrument is switched on Push-button to switch on the instrument
13	SWEEP	Push-button for selection of mode SWEEP
14	BLANKING	Push-button for blanking during flyback
15	CARRIER OUT	Output of the selected fixed marker frequency (item 7) as RF signal (5.5 MHz, 10.7 MHz or 38.9 MHz). Amplitude adjustable with item 3.
16 } 17 } 18 }	MARKER	ON : Variable marker is switch on (marker frequency can be adjusted with MARKER FREQUENCY within the selected range). MOD: The marker generator is modulated with one of the fixed marker frequencies selected by mode switch 7 RF: to obtain marker frequency as an RF output signal (push-button ON, item 16, should then also be pressed)

<i>Item</i>	<i>Description</i>	<i>Function</i>
19 } 20 } 21 }	V	– “+” } Output of bias voltage 0...30 V, 50 mA max. – “–” } (e.g. for bypassing AGC circuits) – Control to adjust the output level of the bias voltage (0...30 V)
22	RF OUT	Output of the sweep frequency generator
23	–dB	Control for continuous attenuation (0...80 dB) of the sweep-frequency amplitude

2.3. Controls and sockets at the rear (Fig. 4)

<i>Item</i>	<i>Description</i>	<i>Function</i>
24	—	Calibration possibility for adjustment of the highest frequency of the marker generator in the selected range. A separate adjustment must be performed for each range.
25	—	Calibration possibility for adjustment of the lowest frequency of the marker generator in the selected range. A separate adjustment must be performed for every range.
26	—	Mains fuse 125 mA, delayed action, for 220 V mains 250 mA, delayed action, for 110 V mains
27	—	3-pole mains connector
28	X-AMPL	Potentiometer for adjusting the amplitude to the X input of an oscilloscope
29	FREQUENCY	Potentiometer for adjusting the sawtooth frequency (8 ... 50 Hz)
30		Chassis
31	SAWTOOTH FREQUENCY OUT	Output socket for the X deflection of an oscilloscope



7-0314
110-250V 50-60Hz

Frequenz

W

Set 0,125 B

220V 25VA

X-Amp.

W

24 25

26 27 28 29 30 31

2.2.4. Application range

For item numbers refer to Figs. 3 and 4.

2.2.4.1. RF Generator

- Switch on the instrument by pressing push-button POWER (item 12)
- Select with range selector RANGES IN MHz (item 6) the required frequency range
- Adjust with the MARKER FREQUENCY control (items 4 and 5) for the required frequency on the scale
- Press push-buttons MARKER ON (item 16) and MARKER RF (item 18)
- The RF signal is available at BNC connector RF OUT (item 22)
- The amplitude of the RF signal can be adjusted with control –dB (item 23)

Remarks

- The output impedance is $75\ \Omega$

Range	Output amplitude
3 - 6 MHz	100 mV _{p-p}
4 - 7 MHz	
7 - 12 MHz	
30 - 50 MHz	
45 - 85 MHz	
85 - 150 MHz	50 mV _{p-p}
150 - 270 MHz	
460 - 860 MHz	
	20 mV _{p-p}

2.2.4.2. RF Generator, amplitude modulated

- Perform the basic adjustment as given for RF generator (see 2.2.4.1.)
- Set the marker switch (item 7) to position 1 kHz MOD.
- The RF signal, available at connector RF OUT (item 22), then is modulated with an internal 1 kHz signal; the modulation depth amounts to 30 %.

2.2.4.3. Sweep frequency generator without markers

- Switch on the instrument by pressing push-button POWER (item 12)
- Select the required frequency range with range selector RANGES IN MHz (item 6)
- Press push-buttons SWEEP (item 13) and BLANKING (item 14)
- The RF signal swept is available at BNC connector RF OUT (item 22)
- Connect the object under test (e.g. a T.V. set) to connector RF OUT. Consult the service documentation of the object under test
- Connect the X input of an oscilloscope to sockets SAWTOOTH FREQUENCY OUT (item 30) and earth (\perp item 31) at the rear of the instrument.
- The oscilloscope must be set for external deflection.
- Adjust the amplitude of the sawtooth for the required deflection by means of potentiometer AMPLITUDE (item 28) at the rear. If necessary, shift the X position.
- Set control SWEEP WIDTH (item 2) to maximum
- Connect the output of the object under test (demodulated signal) to the Y input of the oscilloscope
- Reduce the sweep-width by using control SWEEP WIDTH (item 2)
- Correct the centre frequency by using control CENTRE FREQUENCY (item 1) so that the bandpass curve appears on the screen of the oscilloscope
- Adjust the sweep frequency by using potentiometer FREQUENCY (item 29) at the rear so that the band-pass curve is no longer distorted by the sweep frequency

2.2.4.4. Sweep frequency generator with variable marker

- Perform the basic adjustments as given for sweep frequency generator without markers (see 2.2.4.3.); however, the output of the object under test (demodulated signal) must then be connected to connector Y-IN (item 10) and the Y input of the oscilloscope to connector Y-OUT (item 9).
- Press push-button MARKER ON (item 16)
- Adjust the marker amplitude by means of control MARKER AMPLITUDE (item 8)
- Select within the selected range the marker frequency with controls MARKER FREQUENCY (items 4 and 5)

2.2.4.5. Sweep frequency generator with variable marker and modulated fixed marker

- Perform the basic adjustment as given for sweep frequency generator with variable marker (see 2.2.4.4.)
- Switch on the fixed marker, e.g. 5.5 MHz (item 7)
- Press push-button MARKER MOD. (item 17)

2.2.4.6. Sweep frequency generator with sub-carrier

- Perform the basic adjustment as given for sweep frequency generator without markers (see 2.2.4.3.)
- Switch on the fixed marker, e.g. 5.5 MHz
- Interconnect output RF OUT (item 22) with output SUBCARRIER OUT (item 15) via a T-piece adaptor (e.g. PM 9067, one BNC male → two BNC females)
- Connect the common output to the test circuit (e.g. f.m. - i.f. amplifier)
- The sub-carrier amplitude can be adjusted with potentiometer CARRIER AMPLITUDE (item 3)

2.2.4.7. Fixed carrier

- Switch on the instrument by pressing push-button POWER (item 12)
- Select the carrier frequency (5.5 MHz, 10.7 MHz or 38.9 MHz) with the marker switch (item 7)
- The fixed carrier is available at connector CARRIER OUT (item 15)
- The amplitude of the carrier can be adjusted with control CARRIER AMPLITUDE (item 3)

Remark

The output level amounts to 200 mV, and is continuously adjustable from 0 to > 25 dB.

2.2.4.8. Marker-characteristic

The marker-characteristic of the variable marker oscillator changes in the highest UHF range at about 800 MHz as shown in Fig. 5. The marker-width may be increased up to several 100 kHz. But the frequency accuracy is not influenced because the interpolation of the adjusted frequency is obtained in the same way as in the other ranges (centre between two maxima).

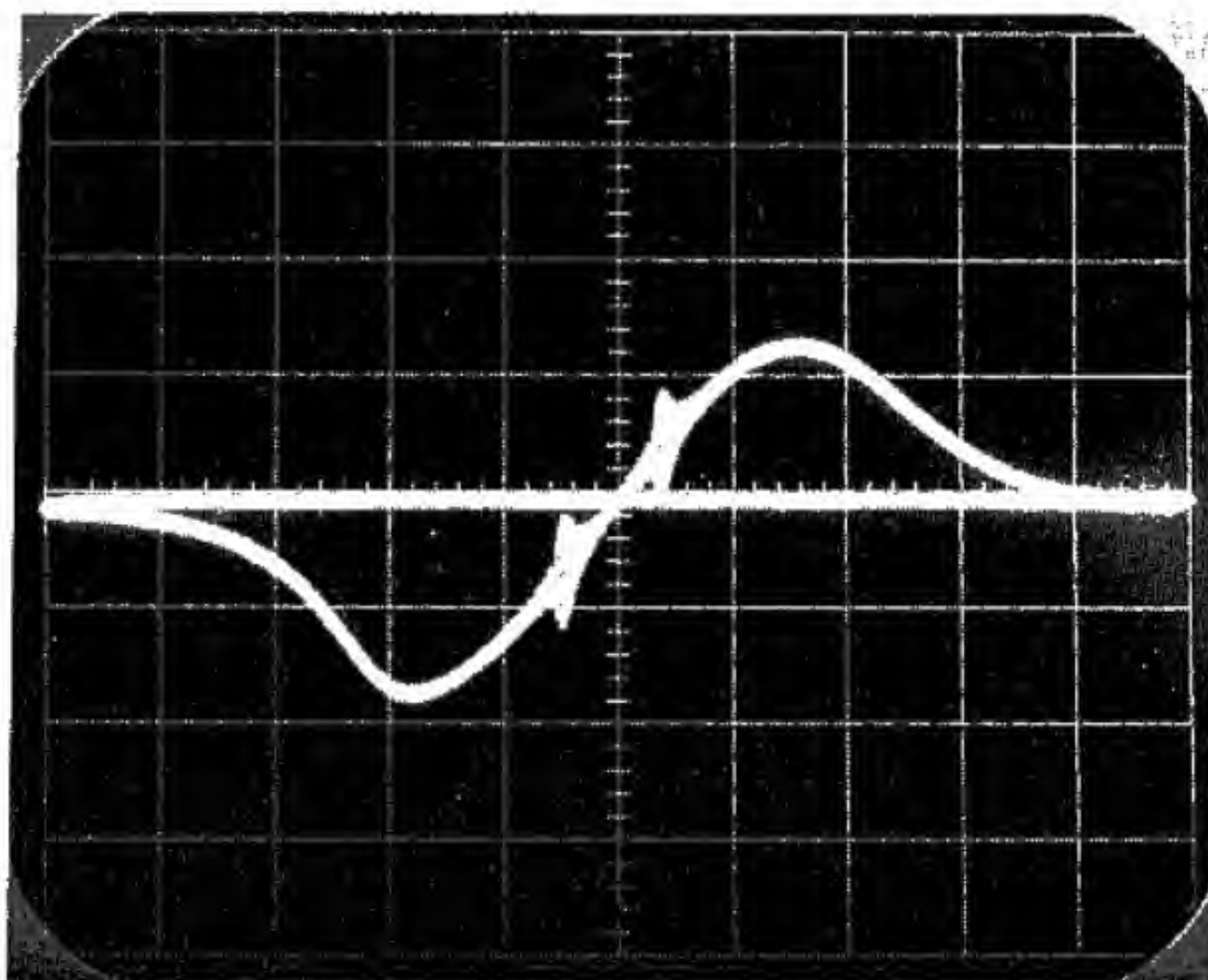


Fig. 5. Marker characteristic at high frequencies

2.2.5. Adaptation of the fixed marker frequency

In those countries where a different sound-visio distance and/or a different i.f. frequency are used than those generated in the standard version (5.5 MHz and 38.9 MHz respectively) the fixed marker oscillator must be adapted to the required frequency. However, bear in mind, that for this adjustment a counter (bandwidth at least 45 MHz, accuracy 0.01 %) should be available).

For adaptation proceed as follows:

- Remove the top plate
- Remove the left-hand side plate
- Connect a counter to connector CARRIER OUT
- Press push-button MARKER ON
- Set the marker switch to 5.5 MHz
- If necessary, adjust the output frequency to the required sound-visio distance frequency (4.5 MHz or 6.5 MHz) with coil L600
- Set the marker switch to 38.9 MHz
- If necessary, adjust the output frequency to the required i.f. frequency (39.5 or 45.75 MHz) with coil L602

2.2.6. Calibration

The frequency of the variable marker generator may be calibrated in two ways, viz.

- by checking - and if necessary adjusting - the output frequency by a counter.
However, bear in mind that, for this check, a counter with a bandwidth of 860 MHz and an accuracy of at least 0.1 % should be available.

For adjusting, reference is made to chapter 3.5.5.1. .

- by zero beat checking with the fixed marks on an indicator (e.g. an oscilloscope). Proceed as follows:
 - Switch on the instrument
 - Set the range selector to range 3-6 and set the pointer to 5.5 MHz with controls MARKER FREQUENCY
 - Press push-buttons MARKER ON and MARKER RF
 - Interconnect connectors RF OUT and Y IN
 - Press push-button MARKER MOD.
 - Connect the indicator to connector Y OUT
 - Set the marker switch to 5.5 MHz
 - As the variable marker frequency of about 5.5 MHz is mixed with the fixed frequency of 5.5 MHz, a sharp limited minimum between two full scales is indicated on the indicator, provided that both frequencies are equal.

In this way the next ranges can be checked:

<i>Fixed marker</i>	<i>Range</i>
5.5 MHz	3 - 6
5.5 MHz	4 - 7
10.7 MHz	7 - 12
38.9 MHz	30 - 50

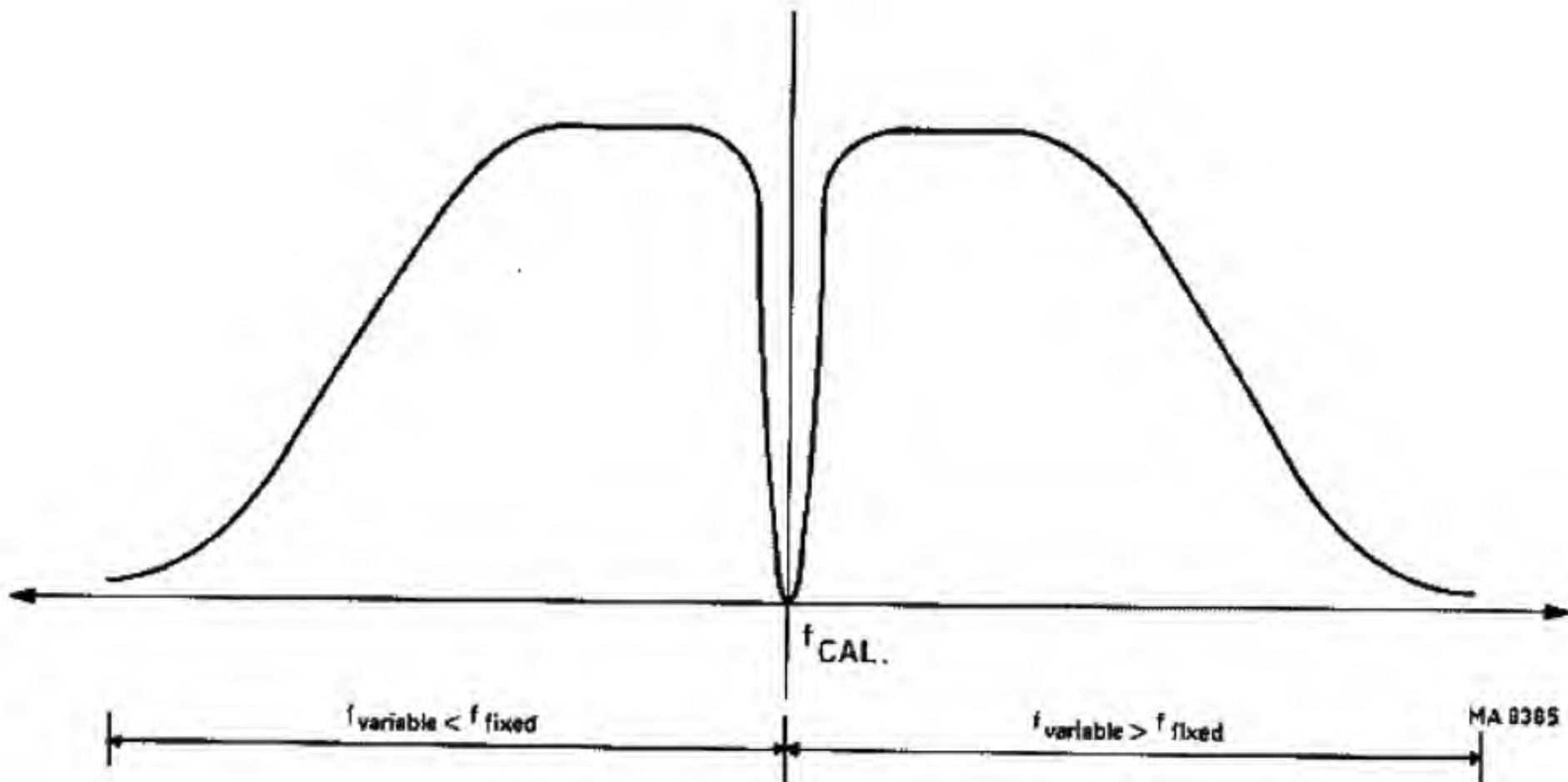


Fig. 6. Zero beat calibration

2.3. APPLICATION EXAMPLES

2.3.1. I.F. curves

2.3.1.1. General

For determining the i.f. bandpass curve of black/white- or colour television receivers on an oscilloscope, 2 signals should be available:

- a swept RF signal, which is supplied to the i.f. amplifier and, after detection, is used as an Y-signal for the oscilloscope
- a X-signal for the horizontal deflection of the oscilloscope

Both signals can be obtained from TV sweep generator PM 5334.

2.3.1.2. I.F. curves without markers

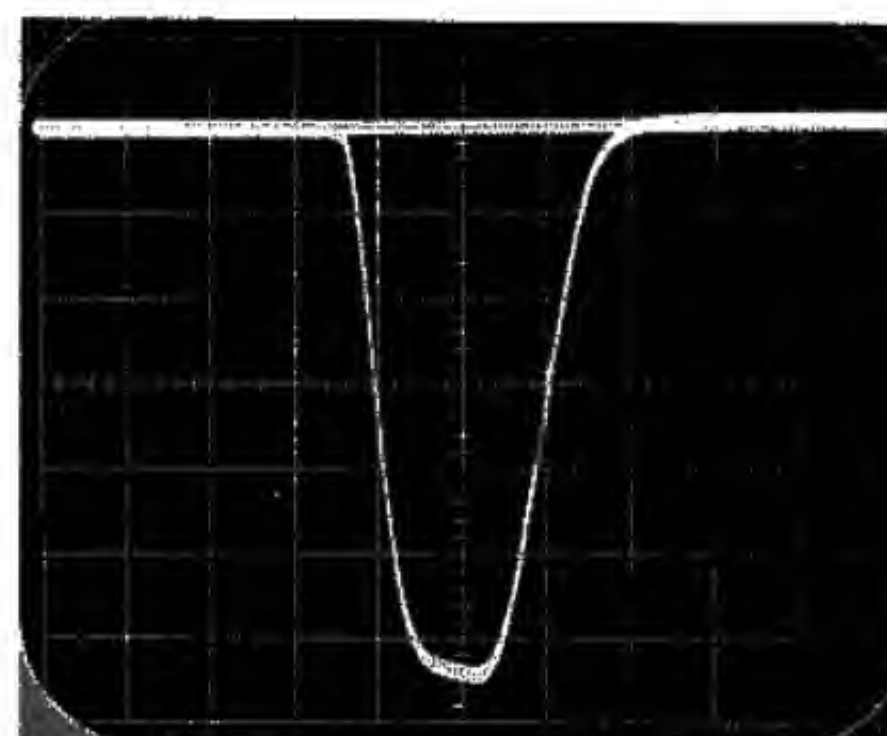
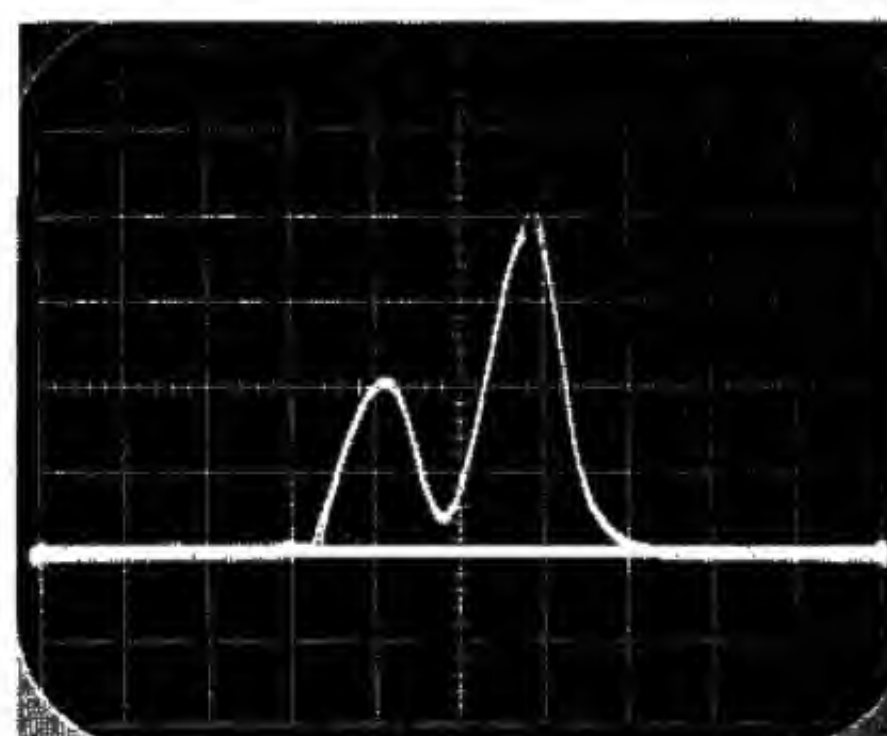
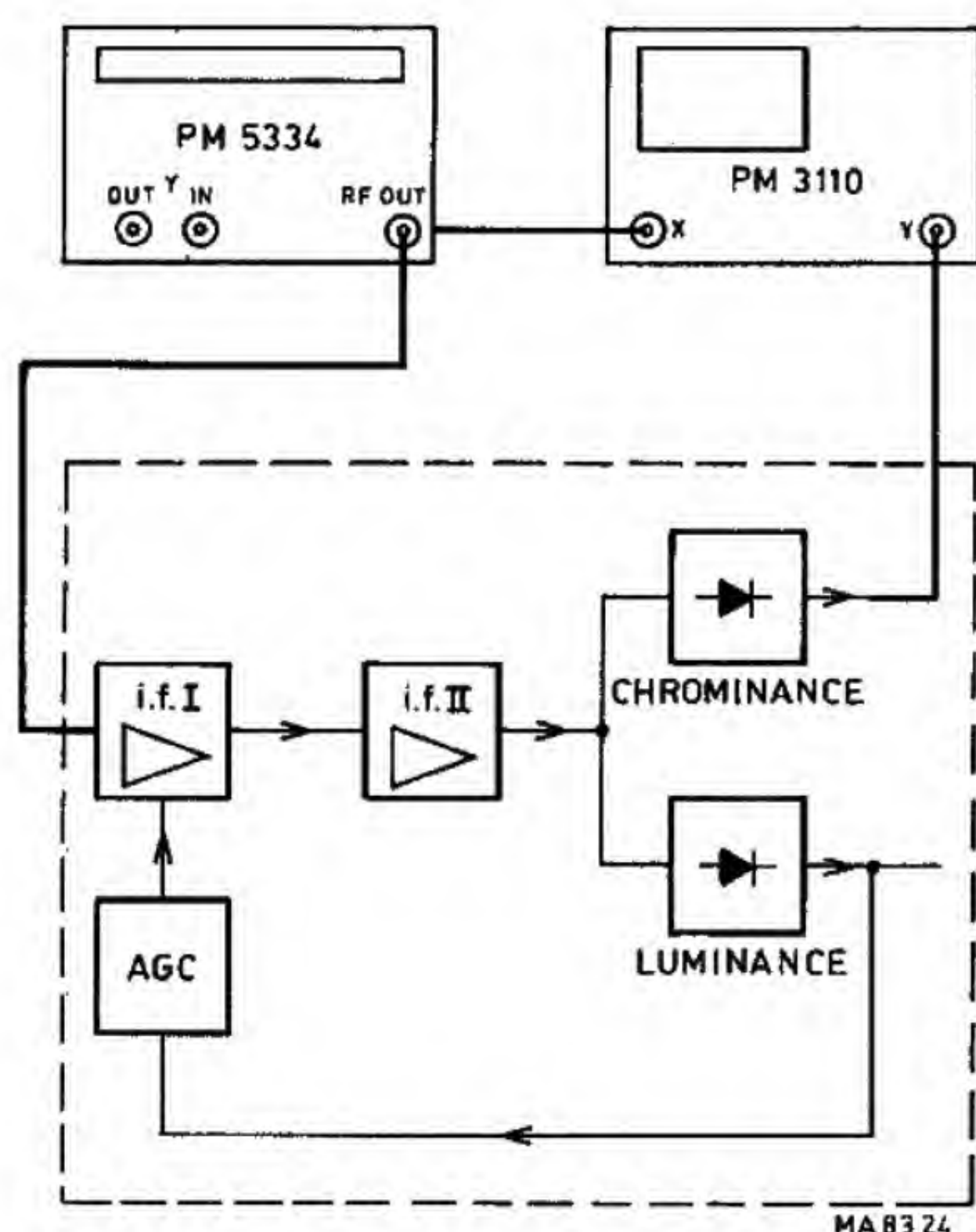


Fig. 7. Measuring the i.f. bandpass curve (with markers)

Set-up

- Set control RANGES IN MHz to 30-50.
- Set up in accordance with 2.2.4.3.

Remarks

- By pressing button SWEEP, a swept RF signal of at least 20 MHz is available at output RF OUT.
- By pressing button BLANKING the RF signal is suppressed during the flyback. Thus a zero line indication is obtained.
- The RF signal is supplied to the first i.f. amplifier. The connection point is stated in the service documentation of the receiver. The supplied RF signal may not overdrive the test object. If necessary, decrease the output voltage by means of potentiometer dB.
- Switch off the AGC voltage and replace the AGC voltage by a fixed value (see documentation of the receiver). If necessary, the bias voltage available from the generator can be used.

2.3.1.3. I.F. curves with markers

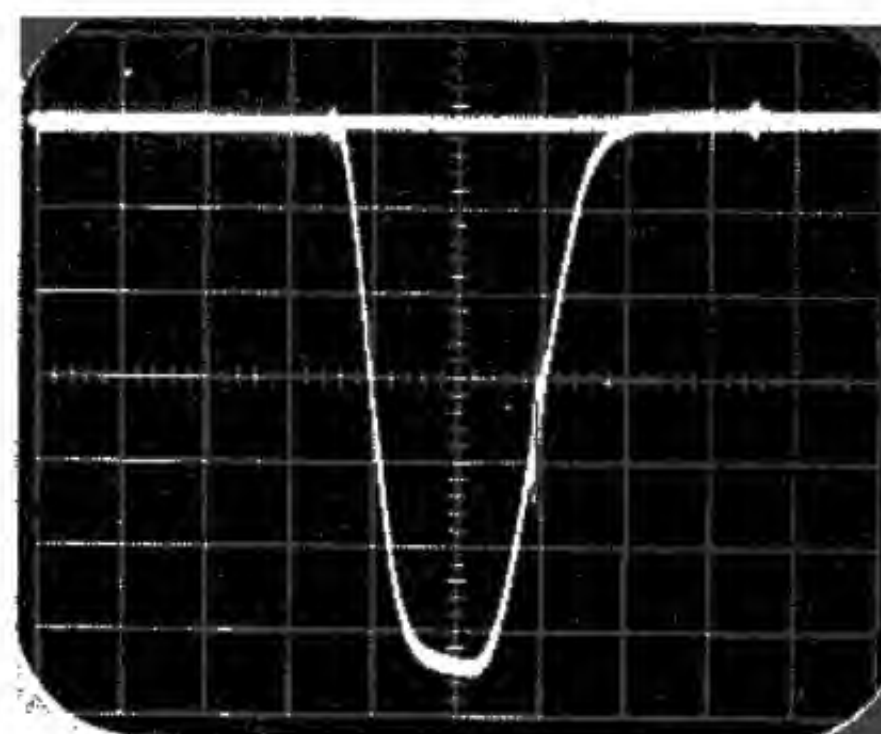
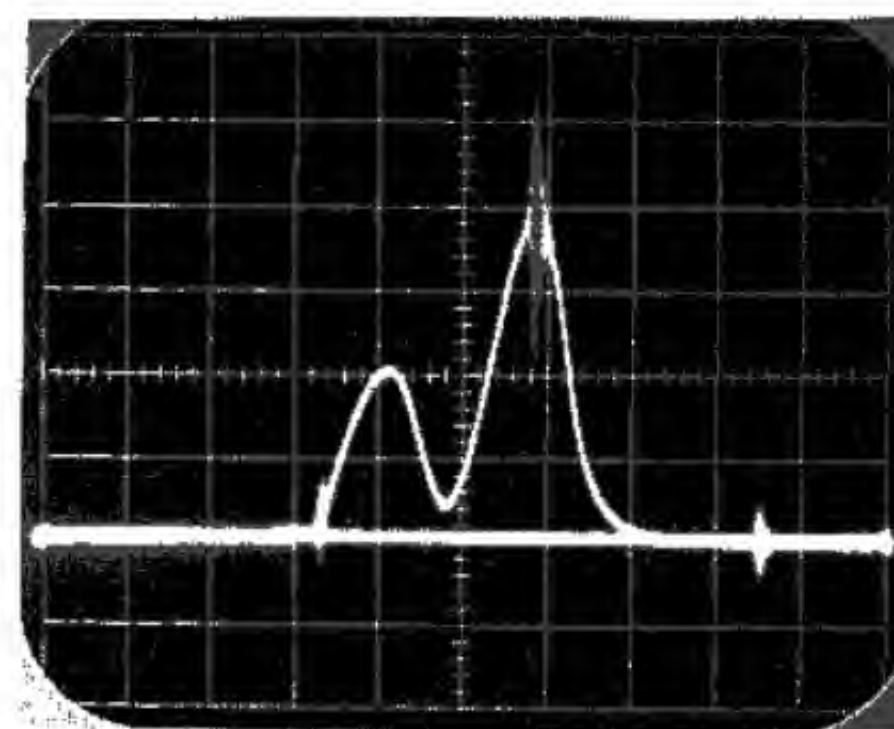
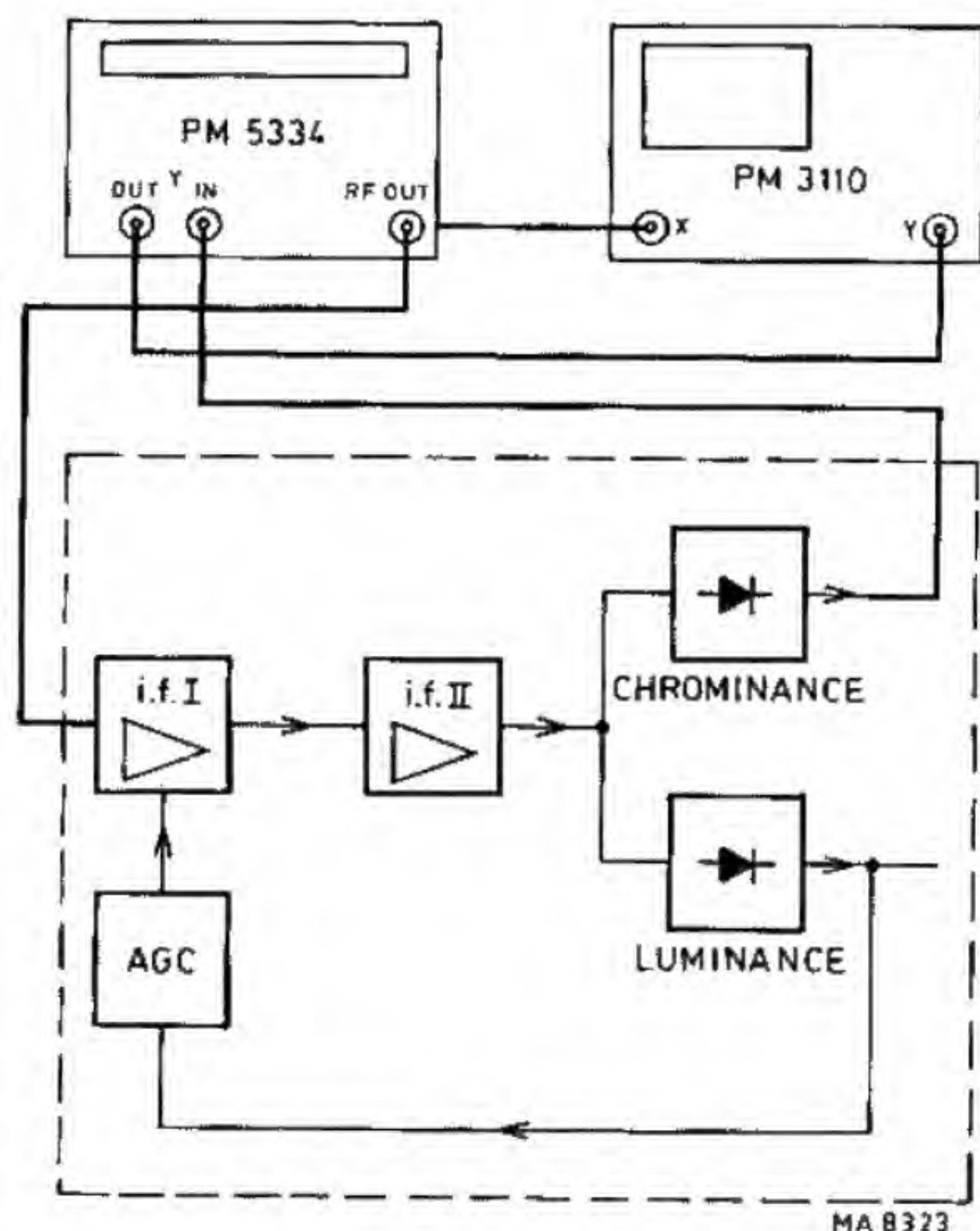


Fig. 8. Chrominance and luminance curves with markers

- Set control RANGES IN MHz to 30-50.
- Set up in accordance with 2.2.4.4.
- Set the variable marker frequency to 38.9 MHz with controls MARKER FREQUENCY.

Remark

It is also possible to obtain fixed markers at a distance of e.g. 5.5 MHz from the variable marker, which enables the adjustment of the picture-sound distance.

Example:

- Set the variable marker to e.g. 38.9 MHz with controls MARKER FREQUENCY
- Set the marker switch to 5.5 MHz
- Press button MARKER MOD.

In this way three markers are available, viz.:

variable marker at 38.9 MHz

fixed markers at $38.9 - 5.5 = 33.4$ MHz

and at $38.9 + 5.5 = 44.4$ MHz

The amplitude can be adjusted with potentiometer MARKER AMPLITUDE.